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Indexes for the previous 6 months will be found in the First number of July and the First number of January.

Books.—We will forward by express, at publisher's lowest rates, any book—scientific or otherwise—to any address in the United States or Canada. We would suggest to our patrons that to avoid the risk and expense consequent on sending us the money (we do not send books C. O. D.), that orders for books be sent us through the Purchasing Department of the American Express Company.

The Public Lighting Tables of the American Meter Company will be found in the page advertisement of that Company.

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[OFFICIAL NOTICE.]

The American Gas Institute Response Vote.

HEADQUARTERS, AMERICAN GAS INSTITUTE,
25–29 WEST 39TH STREET,
NEW YORK, August 10, 1908.

To the Members of the American Gas Institute: The Committee of Arrangements, for the meeting to be held in New York next October, is very much gratified by the response to the Committee's request for information. The replies so far received indicate a very large attendance; but there are still 700 members who have failed to fill out and return the postal card sent to them. It will materially assist the Committee of Arrangements if these 700 members will be good enough to fill out the postal card and mail at once.

COMMITTEE OF ARRANGEMENTS, by
W. R. ADDICKS, Chairman.

[OFFICIAL NOTICE.]

Wrinkle Department, American Gas Institute.

To the Members of the American Gas Institute: All members of the Institute are earnestly requested to send in as soon as possible contributions for this year's Wrinkle Department report. The success of the Department depends entirely on the co-operation and assistance of the members.

Mail all contributions to Milan R. Bump, Editor, No. 60 Wall street, New York city.

BRIEFLY TOLD.

CURRENT MENTION.—

A WELCOME addition to our library is the new edition of "Modern Retort Settings: Their Construction and Working," by Mr. G. P. Lewis. It is the second edition of this useful book, which goes to show that its publishers, Messrs. John Allan & Co., of London, England, were not far wrong in their initial announcement that the book would be found useful to many. It has been found so on this side of the Atlantic, as our sales' book records show. The current volume has been brought completely up-to-date, in that the original chapter on the construction of retort benches and settings has been extended to cover the building of verticals. The same may be said of the divisions treating of the analysis of flue and waste gases, in which section late developments in the automatic analysis of flue gases are plainly described and recorded. So also with the paragraphs relating to pyrometry. The cost of the book ($1.50) remains unchanged.

LATE last week we learned that Secretary George F. Montgomery, of the Railroad Commission of the State of Georgia, had advised Manager Congdon, of the Atlanta Gas Light Company, that the Commission had decided adversely on the petition of one William H. Terrell, an Atlanta attorney, who sought thereunder to compel the Company to reduce its selling rate for gas to 75 cents per 1,000 cubic feet—a cut of 25 cents per 1,000. The Company's main reliance on the witness stand naturally was Manager Congdon, and if everyone concerned in a case of this nature would prepare himself for the ordeal as Manager Congdon did there would be less confusion shown and more perspicacity displayed. Major Terrell conducted his own case and candor compels the admission that he conducted it well considering raftily, but his flights of speech were as chaff in the [illegible] when these

LIBRARY OF CONGRESS. AUG 17 1908 SMITHSONIAN DEPOSIT.

mere wordings were measured with the bare, concise facts submitted by his opponent. When the full text of the decision is handed down we will publish it.

MR. EUGENE H. MATTHEWS, Manager of the Morristown (N. J.) Gas Light Company, has authorized the construction of a new storage holder. It is to be of the double lift order, rated to retain or contain 150,000 cubic feet.

MR. ADDIS M. WHITNEY, Treasurer of the Clinton (Mass.) Gas Light Company, when spoken to a few days ago regarding the likelihood of the local authorities engaging in the gas business there on public account, remarked: "This Company has not taken sides either way on the question of municipal ownership, which is a matter entirely for the citizens to dispose of. While we are perfectly willing to continue the operation of our plants in Clinton, we are equally willing to sell, at a proper price, if the city so desires. We are fully protected by law. We have nothing to fear on the ground of receiving a price from the city which would be unfavorable to our interests. We do not know of many cases where municipal ownership has been a success, but it is possible that the city might benefit itself by taking over our plants, if some arrangement can be made for the purchase of reliable power from an outside source." Ever the same careful, diplomatic Mr. Whitney.

THE City Council of Hudson, Wis., has adopted a series of resolutions which provide for the construction there of a gas plant, "for the manufacture and distribution of gas for fuel, lighting and other purposes, at a cost not to exceed $30,000, on such site as this Council may hereafter select and approve. It is also directed that the City Clerk (Mr. A. Karas) be instructed to advertise for bids for the purchase of city bonds, in the sum of and for the purpose named, such bids to be opened at 1 P.M. of August 8th.

THE Public Service Commission for the Second New York District has granted the petition of the projectors of the Citizens Electric Service Company, of Bath, for consent to their construction and operation of an electric lighting plant in Bath and the surrounding villages and towns. The chief objector to such consent was the existing Bath Gas and Electric Company, the opposition being chiefly based on the fact that there was not sufficient business of the sort under consideration to even partly support two companies, wherefore opposition would impair, if not completely wipe out, the investings of those first in the field. The complainant's case on the face of it seemed fairly proper and just, but the Commission evidently largely based its negative decision on the disinclination of the existing Company to make several line extensions. The full report of the opinion of the Commission is awaited with interest.

MR. JOHN H. BROWN, the former President of the defunct Western Gas and Investment Company, of Chicago, is preparing to put his house in order once more by taking all the benefits that may accrue to those who make their way judicially through bankruptcy. The final hearing in his case is set for October 5th.

AT a special meeting of the Common Council of Herrin, Ills., held some days ago, a franchise to construct and operate a gas works was granted to Mr. W. H. Harrison, Jr., of Biloxi, Miss. The franchise is to run for 30 years. It is stipulated that construction work under the franchise must be commenced within a year, and that the plant shall be in readiness to supply gas within a period of 18 months from the granting of the right.

"V. M. M.," writing from Buffalo, N. Y., under date of the 12th inst., incloses the following: "Yesterday the Buffalo Gas Company served notice upon the city authorities that it will shut down the city's gas supply on the 10th prox., unless the city in the mean time arranges to pay for its gas the same as private consumers. Notice also is served on the city that it must prevent the Buffalo Natural Gas Fuel Company from selling its gas to private consumers who use it for illuminating purposes. The Buffalo Gas Company says it has supplied gas to the city since July 1, 1907, and that it has not been paid for it. There is now due the Company, exclusive of interest, $124,000. This is for illuminating gas used in street lamps. The Company avers that the average consumption of illuminating gas per capita per year in Buffalo is 1,460 cubic feet, which is three or four times lower than any other city in the country and due directly to the extensive use of natural gas for illuminating purposes. Some time ago the city sought to have the price of gas lowered and instituted proceedings before the former Commission of Gas, Water and Electricity, which ruled that 95 cents per 1,000 feet was a just charge. The city had been paying 75 cents and the Company now wants 95 cents, the same as paid by private consumers. The trouble is due to failure to agree on the price. Nothing can be done until the Common Council convenes again on September 8."

Pneumatic Tube Service of the Post Office Department.

[Prepared for the JOURNAL, by "O."]

In reports from various municipalities we often note recommendations that a comprehensive plan showing all underground construction be inaugurated. Although plans of this kind are often started they are rarely completed and continued for various reasons, the principal one being the lack of funds. That they are important, however, is becoming more evident every year, owing to the numerous extensions of existing sub-surface structures and the advent of others for purposes entirely new.

One of the latest is the pneumatic tube service of the Post Office Department, which was inaugurated officially in the city of Philadelphia, March 1, 1894. The Government, through the Post Office Department, contracts for the service, the contractor lays the pipe lines, equips the stations and handles the carriers, etc. In 1906 contracts were let for over 60 miles of these lines in the cities of Boston, Mass.; the Boroughs of Manhattan and Brooklyn, New York city; Philadelphia, Pa.; Pittsburgh, Pa.; Baltimore, Md.; Cincinnati, O.; Chicago, Ills.; Kansas City and St. Louis, Mo. About half of the work under these contracts has been completed and the lines are in use. The cost per mile is approximately $16,000 per annum. The tubes are 8-inch pipe with a combination joint, being hub and spigot pipe, turned and bored, then yarned and leaded. In laying, it is important that the pipes are thoroughly clean and lined with as little grade as possible. They are all carefully swabbed with oiled plungers

Fig. 1.—Eight-Inch Steel Pipe, Pneumatic Tube Service.

Fig. 2.—Ninety-Degree Bend, Pneumatic Tube Service.

and laid upon bed blocks, the grades being determined by means of transit level. The pipes shown in Fig. 1 are all ready for laying on 39th street, New York city, West of 8th avenue. All turns are made with bends of easy curvature, the joints used at these points being flange. The difficulties surrounding work of this character are illustrated in Fig. 2, where the pipes in question may be noted at the bottom of the excavation beneath a network of gas and water mains,

The Commercial Side of the Gas Industry.[1]

By Mr. Lucius S. Bigelow.

It is self evident that we are to-day living in an age of specializing. If this were not the case, then there would be no "Commercial Side" to this or any other industry. Since, however, things in this world do go by comparison, we can truthfully claim that there is a "Commercial Side" as distinctive from the engineering and construction side in the gas industry.

"In the beginning" all things were one, and as a result nothing desirable was apparent. It was then that the Great Maker of all things set the example of specializing. He said, "Let there be light." He separated the water from the dry land. He gave to each a name, and ever since that time the world has continued to specialize to a greater or less degree. The greatest successes, however, have been those wherein the plan was exampled after that so successfully instituted at the time of the creation. For many years it was solely the endeavor of the gas manager to manufacture his element, allowing the selling of it to be a matter of "take it if you will." Such conditions, however, it has been shown, do not make for large development. Some have criticized our brothers across the Atlantic, because it has been said, "they are inclined to take things after a very easy fashion, and to do as was the custom of the fathers." I, however, desire to cite the fact that some of the best commercial gas work has been done in Great Britain, and a clever example has been there set to us on this side of the Atlantic.

The Manchester exhibition of gas appliances, of which, as I recall it, Mr. Thomas Newbigging was Chairman, stood out as a splendid example of what has been accomplished commercially in the gas field across the way.

Let me ask, what is the commercial side composed of, and what does it comprise? In Great Britain he who we term the "appliance manufacturer" is, as you know, termed "a trader." If you will bear with me, should I interchange these terms in addressing you, I will proceed with the knowledge that you will understand my meaning, in the event of my using either title.

The commercial side of the industry may itself be properly divided. On the one side is the gas manager, commercial agent of the gas company; or, as the head of the commercial department of a gas company is frequently termed, the new business manager. On the other side, the manufacturer of gas appliances, or "trader," each being of the utmost importance to the other. Let me illustrate how important each is, by citing the construction of an arch. On the one side we have laid a foundation of granite, but it is necessary that upon the other side a foundation of equal solidity, proportions and strength should be laid. I would picture in word painting the one foundation as representing the gas man having under his charge the sale of the company's product. The other foundation I would picture as the appliaance manufacturer or "trader." Having these two foundations laid, let us begin the building of our arch. The stones on the one side (the latter if you please) will represent the various appliances devised, perfected and manufactured for the converting of gas into light, heat and power. The stones laid upon the other foundation I will picture as gas sales, wherein the element is to be used for creating light, heat and power in various manners and for various purposes by utilizing the appliances represented by the stones upon the opposite side of the arch. Let us lay our arch, st ne by stone, on the one side *the appliance*, and on the other, *where it may be used*, and as the sides converge, presently we shall find ourselves setting the keystone. This I would picture as the commercial side of the gas industry, which, but a few moments since, I divided, but have now indicated as a complete whole, builded of two divisions, which, though laid upon entirely separate foundations, are of equal importance in the supporting and maintaining of a unit, "The Commercial Side of the Industry."

While describing or picturing the architectural construction of the commercial side of the gas industry, we must not ignore the fact that no piece of work can be constructed without the assistance of the engineer. It is the gas engineer who, back of the gas company's plant, provides the element which, sold through the sales office of the gas company, returns the dividend to the stockholders. And it is his brother, the mechanical engineer, who, back of the foundry and the machine works of the appliance manufacturer, supplies the important preliminaries to the producing of the appliances absolutely necessary to the converting of the element into light, heat and power.

Let me for a moment point out the advantages to be derived by admitting the appliance manufacturer, or "trader," upon an equal footing, within the Holy of Holies of the gas fraternity. In doing this, however, I shall find it necessary, perhaps, to subdivide the Holy of Holies, as I advocated in the United States when, some 4 years since, I proposed the forming of a National Commercial Gas Association which should have as its slogan "the selling of millions of feet of gas where thousands are sold to-day,' and which should have printed upon its programme, from year to year, only such titles as would indicate the considering of purely commercial subjects. Such, for instance, as "The Gas Appliance;" "The Maintaining of Gas Appliance Standards;" "The Introducing of Gas Appliances in the Stores, Homes, Factories, etc., of the People;" "Methods for the Maintaining of these Appliances;" "Gas Advertising Methods;" "Gas Sales' Promotive Methods," etc. While, at the same time, advocating a magnificent enterprise in the form of a gas engineers' society, or institute, each body co-operating with the other, but neither body absorbing the other.

This plan was but the following out of the example that I have indicated as having been set at the creation of the world – specializing.

There is to-day, and there always will be, need for the constant, careful and thoughtful considering of those matters which have to do with the chemistry of gas, its manufacture and distribution. At the same time, unless the utmost systematic, thoughtful and serious consideration is given to the appliance and the sale of the gas, the works must go begging and the stockholder must go without his dividend.

It has been my feeling that when men meet together in convention sessions they should converge with but one thought and one purpose. Therefore, the engineering society as a separate institution from the commercial association, and *vice versa*. In the United States the gas interests are so large as to make it quite possible to support both an engineering society and a commercial organization. Such conditions may not exist in Canadian fields. You know best about this and whether such a division as we have created in the States could possibly prosper here. Please understand that I am not advocating two associations *here*, but such is possible in the States and has been successfully accomplished.

The next meeting of the National Commercial Gas Association will be held in Chicago, December 8th, 9th and 10th, and during that week there will be an immense display of appliances for converting gas into light, heat and power. These appliances will be displayed in the enormous floor space of the First Regiment Armory. Those from Canada who can make it convenient to be present, whether or not members of the National Commercial Gas Association, are most earnestly invited and will be made heartily welcome. I extend this invitation as Secretary of the National Commercial Gas Association.

Before closing I desire to call your attention to a series of photographs taken of window displays made by a gas company just across your borders. I refer to the Detroit City Gas Company, Detroit, Mich., one of the very energetic companies of our country, through whose courtesy I am enabled to show you these reproductions of their "window dressing" at various seasons of the year.

The Detroit Company has found this method of interesting the public a most desirable one, and upon inspecting the photographs you will readily appreciate why, for certainly they have been made most attractive, suggestive and convincing. These pictures help to indicate to what perfection has been brought the "Commercial Side of the Gas Industry."

1. Read by the anthor at the First Annual Meeting of the Canadian Gas Association, and received too late for our regular publication of the "Proceedings" of that meeting.

Standards Adopted by the Railroad Commission of Wisconsin, Anent Public Service Lighting Companies.

The Railroad Commission of Wisconsin has formulated and prescribed the following rules for standards to guide the public lighting companies of the State in their dealings with consumers:

Rule 1. A meter may be considered as correct if, when passing gas at the rate of 6 cubic feet per hour per light capacity, it shows, in comparison with a standard gas prover, an error which is not greater than 2 per cent.

Rule 2. No gas company shall allow a gas meter to remain in service for a period longer than 3 years without checking it for accuracy and readjusting it if found to be inaccurate.

Rule 3. Each company shall keep a record of tests made on meters before installation and upon receiving them from the services.

Rule 4. Each gas company shall provide itself with equipment necessary for testing meters, such equipment to consist of a standard meter prover with suitable accessories.

Rule 5. Each gas company shall make a test of the accuracy of a meter upon request of a consumer, provided such consumer does not make a request for test more frequently than once in 6 months. A report giving the results of such tests shall be made to the consumer, and a complete record of such tests shall be kept on file in the office of the company.

Rule 6. Upon formal application of any consumer to the Railroad Commission a test shall be made upon the consumer's meter by an inspector employed by the Railroad Commission, such test to be made as soon as practicable after receipt of the application. For such test a fee of $2 shall be paid by the consumer making application for the test if the meter is found to be slow or correct within the allowable limits, and by the company owning the meter if the meter is found to be fast beyond the allowable limit.

Rule 7. Meter dials shall read directly in cubic feet of gas, and bills rendered periodically by the company shall designate the readings of the meter at the beginning and end of the time for which the bill is rendered, and give the dates at which the readings were taken.

Rule 8. The company furnishing gas which, within a 1 mile radius from the distribution center, gives a monthly average total heating value of not less than 600 B.T.U., with a minimum which shall not fall below 550 B.T.U., may be considered as giving adequate service as far as the heating value of the gas is concerned.

Rule 9. Each gas company, whose output exceeds 20 million cubic feet a year, shall equip itself with a standard calorimeter outfit, with which periodic tests shall be made. A record of these tests shall be made and kept open for public inspection.

Rule 10. Gas pressure, as measured at meter inlets, shall never be less than 1½ inches nor more than 6 inches of water pressure, and the daily variation of pressure at the inlet of any one meter on the system shall never be greater than 100 per cent. of the minimum pressure.

Rule 11. Each company shall make frequent measurements of the pressure and pressure variations, and these shall be kept on record and open for public inspection.

Rule 12. In no case shall the gas contain more than 30 grains of total sulphur per 100 cubic feet, and not more than a trace of sulphur as sulphuretted hydrogen.

Rule 13. Each company shall keep a record of complaints which shall include the name and address of the consumer, the date, the nature of the complaint and the remedy. A classified summary of these records shall be submitted to the Commission on or before the 28th day of each month for the preceding month.

Rule 14. No electric meter which registers upon "no load" shall be placed in service or allowed to remain in service.

Rule 15. No electric meter shall be placed in service or allowed to remain in service which has an error of registration in excess of 4 per cent. on light load, half load or full load.

Rule 16. Each electric service meter shall be tested and adjusted for accuracy at the time of its installation.

Rule 17. Each electric service meter shall be tested at least once each year; the test to be made by comparing the meter while connected in its place of service with suitable standards, on light load, half load and full load rate of operation.

Rule 18. A complete record shall be kept of all tests made on electric meters.

Rule 19. Each company supplying electrical energy shall provide itself with suitable equipment for the testing of meters, and shall employ such methods as are approved by the Railroad Commission.

Rule 20. Each company supplying electrical energy shall make a test of the accuracy of a meter upon request of a consumer, provided such consumer does not make request for tests more frequently than once in 6 months. A report giving the results of such tests shall be made to the consumer, and a complete record of the same shall be kept on file in the office of the company.

Rule 21. Upon formal application of any consumer to the Railroad Commission, a test shall be made upon the consumer's meter by an inspector employed by the Railroad Commission, such tests to be made as soon as practicable after the receipt of the application. For such test a fee of $2 shall be paid by the consumer making application for the test if the meter is found to be slow or correct within the allowable limit, and by the company owning the meter if the meter is found to be fast beyond the allowable limit.

Rule 22. Each company supplying electrical energy shall maintain a record of all interruptions of service upon the entire system or major divisions of its system, and include in such record, time, duration, and cause of each interruption.

Rule 23. Each company supplying electrical energy on constant potential systems shall adopt and maintain a standard average value of voltage as measured at any consumer's cut out, which shall remain constant from day to day, and vary during any one day by an amount not more than 6 per cent. of the minimum value.

Rule 24. Each company supplying electrical energy for incandescent illumination shall adopt and maintain some method of procedure which will insure periodic inspection of incandescent lamps to which current is supplied and under which the company will render its consumers assistance in securing incandescent lamps best adapted to the operation of the system. Each company shall submit to the Railroad Commission of Wisconsin the details of such method of procedure as it may adopt.

Rule 25. Each company supplying electrical energy for incandescent illumination shall specifically inform each of its consumers as to the conditions under which efficient illuminating service may be secured from its system.

The rules are issued in pamphlet form and are discussed at length by the Commission.

Recent Improvements in Connection with Gas Works Installations in Germany, with Special Reference to the Koppers' Patent Inclined Coke Ovens Erected at Bochum Gas Works and to Koppers' Improved Ammonia Recovery Plant.[1]

[A paper read by HERR A. PETERS, of Cologne, before the Rhineland and Westphalian Gas Association.]

The progress which has recently been made in the construction of retort benches at gas works is the result of endeavors to render the working of the plants independent of hand labor, by substituting labor-saving mechanical arrangements. The heavy duties of the workmen are very greatly lightened, as it is now practically only necessary for the men to attend to the mechanical arrangements for charging and discharging the retorts. It is essentially necessary for mechanical means to be provided in connection with horizontal retorts for charging them with coal and pushing out the coke as well as for loading the coke into trucks. The adoption of inclined retorts enables a considerable saving to be effected in the charging and discharging operations. With vertical retorts the coal is fed from above, and the coke falls directly into a coke loading arrangement, which system permits of the charging and discharging operation being effected entirely by mechanical means.

In gas works, the principal object is the production of the greatest possible amount of illuminating gas; the coke obtained is regarded more or less as a by-product. In coke works, on the other hand, the chief aim is, of course, to produce the best possible quality of coke suitable for metallurgical purposes. The gases of distillation obtained in the latter process are employed principally for heating the coke ovens. In gas works, the coke is utilized largely for heating the retorts. In order to obtain a suitable coke from coke ovens, it is necessary for the coal to be of a bituminous or semi-bituminous character, or a mixture of both these kinds. For the production of illuminating gas, on the other hand, it is essential that the coal be of a highly volatile character. The discovery of the incandescent gas mantle has not affected in any way the construction or working of either processes; but it has its effect on the quality of the gas produced, in that it is now not so necessary for the gas to be of a high illuminating power, but to have a higher heating value. The production of gas of uniform quality is just as easily obtained from coke ovens as from ordinary gas retorts, and it depends altogether upon the nature of the coal and upon the method of coking.

In ordinary coke ovens, gas can be produced from so-called fat coal (rich caking coal), lean coal (semi-bituminous coal) and manufacturing coal. The gas from these coals, however, is not of such a highly illuminating character as that from a good gas coal; but it nevertheless has about the same heating value. In the appended statement, the results are given of tests of four varieties of coal which were carefully carried out in an experimental coke oven. Apart from the figures giving the heating value of the gases, the high yield of sulphate will be viewed with the greatest interest. This high yield

1. *Journal of Gas Lighting.*

is due to the relatively small decomposition of the gas in a properly constructed coke oven in which the space provided at the top of the oven for collecting the gases evolved from the coal is maintained at a moderately low temperature.

So that the difference between retort ovens and coke ovens may be clearly understood, a short explanation is given, as follows: In gas retorts, small quantities of coal are carbonized in periods varying from 4 to 8 hours. The retorts are subjected on all sides to a more or less intense heat. The section of the retort is oval in shape, and of dimensions which do not exceed 400 mm. by 650 mm. Coke ovens, on the other hand, are of a very large capacity, having usually a length of 10 meters (32 feet 10 inches), a height of 2.5 meters (8 feet 2 inches), and a width varying from 450 mm. to 550 mm. (18 inches to 22 inches). The greatest length of the retort is 6 meters (19 feet 8 inches), and the capacity does not exceed 10 cwt. The capacity of a coke oven is from 7 to 8 tons; and it is therefore from 14 to 16 times as large as a gas retort. The period of carbonization of a coke oven of modern design is from 24 to 30 hours, and depends upon the arrangement of the heating flues and upon the method of applying the heat to them as well as upon the character of the coal. The extended period of coking and the expeditious method of emptying and filling the oven have a number of important advantages, more particularly in that there is much less loss of heat, less attention is required, and a higher yield of gas is derived. This has been recognized for some time past by gas engineers, and has resulted first of all in the vertical retort being adopted with a coking period of 10 to 12 hours, and, subsequently, in the adoption of the coke oven, with a coking period of 24 hours.

The working of coke ovens differs very essentially from that of ovens designed for the production of illuminating gas, in that the coal contains in the former from 12 to 15 per cent. of moisture, and the coal is, besides, crushed to a very fine state. The moisture in the coal is mostly due to its having been subjected to a washing operation. Water, however, is very often added where the coal is not washed, as it has been found that a better coke is produced from coal containing moisture. The reason for this is that crushed coal in a damp condition is denser than crushed dry coal; and, as a consequence, the resultant coke is also more dense. From some coal fields, such as those in America, where the coal is of a higher specific gravity, a good blast furnace coke can be produced from crushed coal carbonized in a dry state. The moisture in the coal affects the period of distillation, besides which it necessitates a higher temperature for carbonization; and there are, consequently, great variations in the temperature of the oven. As a result of this, the walls of the oven easily become leaky. From the coal carbonized in retorts, from 4 to 6 per cent. of moisture is yielded as virgin liquor. The carbonizing period of a coke oven when charged with dry coal is naturally much lower than when charged with wet coal. The ovens, furthermore, remain tight, and the firebrick material is subjected to less wear and tear.

On reviewing the recent progress which has been made in the gas industry, and comparing it with the history of the coke oven industry, it will be seen that both industries have developed on parallel lines. The manufacture of coke was effected in the first place in a similar manner to that now in use for the production of charcoal. The next step was the employment of brick chambers formed in the shape of a beehive, and which were called beehive ovens. Some time between the years 1850 and 1860, a vertical coke oven, known as the Appolt oven, was introduced. This oven was arranged with heating flues in which the gases of distillation were consumed for the purpose of assisting the carbonization. This type of oven found some considerable popularity at a number of collieries in the Saar district, in Westphalia, and also in Upper Silesia. The oven was much improved upon from time to time, and was eventually arranged with by-product recovery plant. There are a number of vertical ovens of this description still at work at an iron works in Upper Silesia.

The coke industry having been always a progressive one, it was not long before the vertical Appolt oven was discarded, as it possessed the very disadvantageous feature that the heating was by no means uniform. The type of oven which next followed was the horizontal coke oven of the present day. In the past, well known firms—such as Collin, of Dortmund, and Von Bauer, of Munich—have erected large numbers of vertical retorts, in the construction of which they introduced a number of important improvements, and in doing so have rendered great service to the coke and gas industries. In recent years the firm of Dr. Otto & Co., of Dalhausen, have interested themselves very largely with the construction of by-product coke ovens. The oven originally built by this firm was the horizontal type, which was constructed on a design invented by Hoffman. The particular feature of this system was the combination of a horizontal coke oven with Siemens regenerators, which construction met with considerable success.

The coke oven built at the present time can be regarded as the forerunner of the latest development of coke ovens as recently adopted by gas works. The firm of Dr. Otto & Co. obtained a patent in the year 1901 for a gas oven arranged at an inclination, which was designed on the same principle as the ordinary coke oven. About this time, a patent was granted to a Mr. Hermann Schimmel, of Berlin, for a gas oven arranged similarly at an inclination, on which some important improvements were embodied. The feature of the patent was the provisions of means for taking off the gases of distillation during the latter period of carbonization for heating the ovens. This is of special importance for all small and medium sized gas works, and for districts where the coke produced can be sold at a high price. The coke ovens generally in use at colleries are all arranged horizontally. They are charged with coal through several filling holes in the top, or, when the coal is compressed, the ovens are charged by means of a machine through the doors. The coke is discharged by a pushing engine on to a horizontal or inclined bench, whence it is loaded into trucks by hand. The gases evolved from the coal pass into one or two gas collecting mains, from which they are drawn to the residual plant by means of exhausters.

The great bulk of by-product ovens in Germany are arranged with vertical heating flues, as it has been established that it is not possible for an oven arranged with horizontal flues to be uniformly heated. In a vertical-flued oven the heating is effected by means of relatively short flames, while with horizontal flues the flames are of necessity much longer. Long flames are much cooler than short flames, and as the distillation requires a high temperature, it is abundantly evident that the vertical-flued oven is much more efficient than one arranged with horizontal flues. The number of points at which an oven should be heated should be as large as possible, in order to obtain perfectly uniform heating. Vertical-flued ovens having a heating jet in each flue give by far the best results and enable a gas to be produced which can be employed for exactly the same purposes as the gas manufactured in ordinary gas works. As a general rule, ample space is available at coke works for the employment of coke-pushing engines and an extinguishing bench; but with gas works, on the other hand, the space available is often limited. Large gas works have frequently to be erected on the smallest possible space, and the working of the plant is consequently attended with difficulties. In such cases the adoption of inclined coke ovens with mechanical charging and discharging arrangements would be very advantageous.

It is not surprising that a firm who have gained a pre-eminent position in the building of coke ovens should turn their attention to the building of similar ovens for the lighting gas industry, especially such a firm as that of Heinrich Koppers, of Essen-Ruhr, who have already had considerable experience in this direction, which other firms, by the way, have still to gain. The great similarity which has taken place in the progress and development of the methods of carbonizing in gas works and coke works, already referred to, is completed by the employment of inclined coke ovens at gas works, and it can safely be taken that this method of carbonizing will be largely adopted in future owing to the distinct advantages offered by the system. It is more than probable that if the building of this type of oven be attempted by other than experienced coke oven builders the system would be brought into disrepute, as it would be bound to result in ovens of bad and doubtful construction being erected. Gas engineers contemplating this type of oven would be well advised, therefore, to give consideration to only those constructions which have been proved satisfactory by actual experience. The new method not only enables gas of a good and uniform quality to be produced, but also a very satisfactory coke, which would be equal in quality to ordinary coke from coke ovens. The field for the employment of the system, therefore, is very greatly extended.

By the introduction of coke ovens in gas works, the choice of coal would not be so limited as at present. Any variety of coal yielding even a medium quality of gas, but which would produce a satisfactory coke, could be employed. The adoption, furthermore, of the idea in the lapsed patent of Herr Schimmell—to employ the poor gases taken off at the latter period of distillation for heating purposes—would enable a continuous supply of gas of medium heating value to be supplied to the consumer, while at the same time a coke of a valuable character would be produced. This would be attained without the use of

gas coal and by the utilization of coal of a semi-bituminous nature. Rich gas coal itself yields, when carbonized in properly constructed ovens and in which the gas collecting space is not overheated, and in which, furthermore, the walls are uniformly heated, a gas of a better quality, both as regards its heating and lighting values, than has hitherto been possible with gas retorts. The coke is much denser, and can be employed for foundry purposes, for smithies and generally for all metallurgical purposes. The yield of ammonia from coke ovens of good construction is considerably greater than from any gas works retort, as the quantity of ammonia obtained approaches closely to the theoretical amount as ascertained in the laboratory. The results of laboratory tests, when compared with the actual results obtained at many gas works, indicate that a very great loss in by-products takes place, and, therefore, a correspondingly heavy loss in revenue.

Koppers' Waste Heat Oven.—Until within very recent years practically the whole of the gas that was obtained from the distillation of coal in coke ovens was employed for heating the ovens, the waste gases from the ovens being utilized to raise steam. These ovens are still largely used where steam power is required, and are known as waste heat ovens. But the ovens which are now being viewed with the greatest favor are those of the regenerator type, which enable from 45 to 55 per cent. of the total quantity of gas evolved from the coal to be obtained as a surplus for external purposes. The waste heat oven, as built by Koppers, is shown in Fig. 1, and the following is a brief description of the construction and working: The gas distributing conduit *a* is placed directly on the top of the brickwork foundation into which the heating gas is delivered. The gas passes into the heating flues *c* through the nozzles *b*. Alongside this conduit the air distributing flue *d* is placed. This flue is put directly beneath the oven chamber, while the gas flue lies directly under the heating flues. The air passes into the heating flues through the openings *e*, where it meets the gas as it comes through the nozzles and combustion takes place at a point on a level with the floor of the oven. The products of combustion pass up the heating flues and enter the horizontal flue *f*, whence they are drawn down the end flues of the oven into the main waste gas flue leading to the boilers.

The temperature of the heating gases on leaving the oven is about 1,000° C. In the short distance between the gas nozzles and the upper horizontal flue *f*, the whole of the heat which is of value for heating the oven is abstracted by the oven charge. The quantity of heat is about 45 per cent. of that generated by the combustion of the gas and air. Waste heat of less temperature than 1,000° C. is useless for assisting the carbonization process, and is accordingly utilized under the boilers. The gas is supplied to each oven by a separate pipe fitted with a regulating cock. Every heating flue has its own gas jet (nozzle *b*), which does not require either attention or cleaning. The gas nozzles are accessible and removable from the top of the ovens through openings *g*. These openings are fitted with gas-tight plugs, which can be easily removed for inspection purposes. It might be thought that these openings have a detrimental effect on the stability of the ovens. But any fears in this respect would be quite groundless, as up to the present over 3,000 ovens have been erected, and in no single instance has any sign of instability manifested itself. It should, furthermore, be pointed out that each heating flue is furnished at top with a regulating slide, by means of which it is easily possible to attain an extraordinary uniformity in the heating of the walls. The regulation of these slides is effected through the openings in the superstructure of the ovens. As a result of the equal heating of the walls, a large quantity of gas remains over. According to the quality of coal, a surplus up to 100 cubic meters of gas per ton is obtained. The sole of the oven is not subjected to any heat and the resulting coke is dense, large and homogeneous throughout the charge, which is proof of the correctness of the method of heating.

Since the introduction of reliable gas engines of large power, the demand has arisen for coke ovens which will yield a larger supply of surplus gas than is obtainable from waste heat ovens. This demand has resulted in the regenerator oven being now universally viewed with favor.

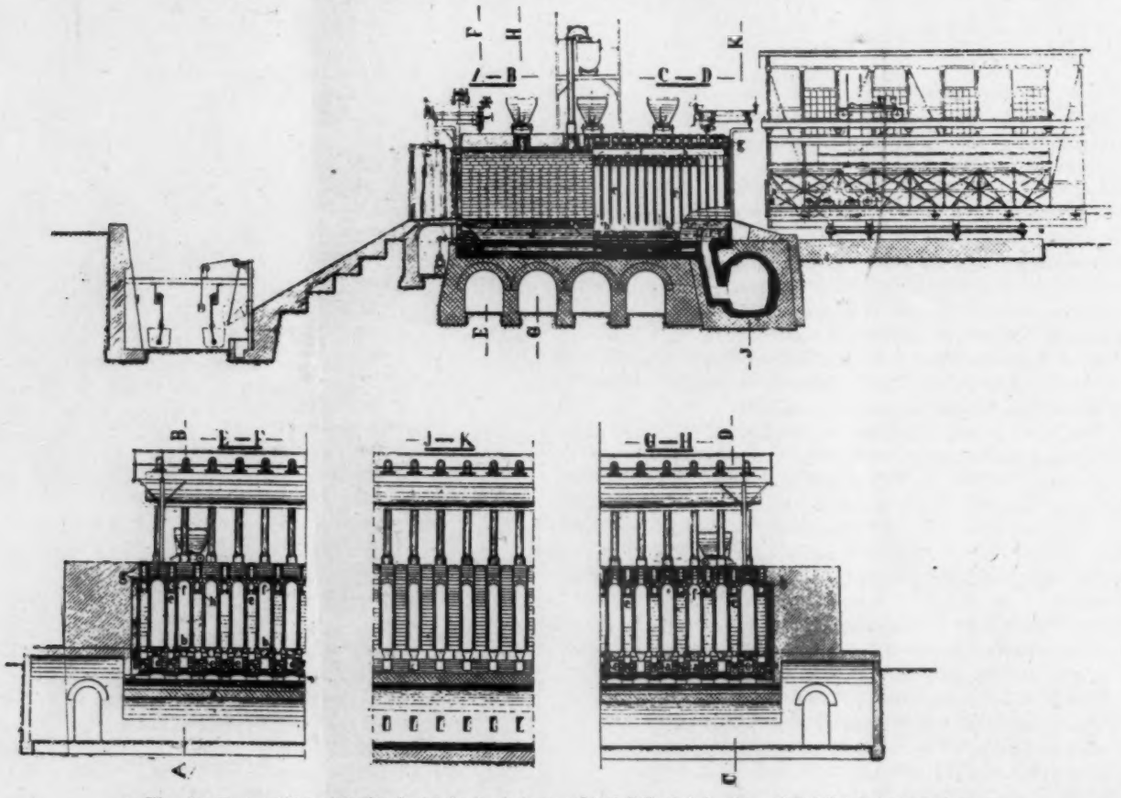

Fig. 1.—Koppers' Patent By-Product Coke Oven, Arranged to Suit the Substructure of Existing Retort Benches.

Koppers' Patent Regenerator Coke Oven. (See Fig. 2.)—The Koppers' latest patent regenerator oven differs from all other types in that it has separate regenerator chambers provided for each oven, instead of one set of regenerators for a whole battery. The construction consists of a series of transverse parallel walls built directly upon a concrete bed. The walls extend to the top of the structure, and are so designed that the lower portion forms the regenerators and the upper portion the oven chamber. Apart from rendering the ovens entirely independent of each other, this construction has the important advantage over all other systems that the regenerator chambers can be made of very large capacity relatively to the room they occupy, while they are so inclosed that the loss of heat by radiation is almost totally avoided.

The air for combustion enters the regenerator *b* from the air passages *a*. In the regenerators the air is heated to a temperature of about 1,000° C., whence it passes into the vertical heating flues *f*, where it

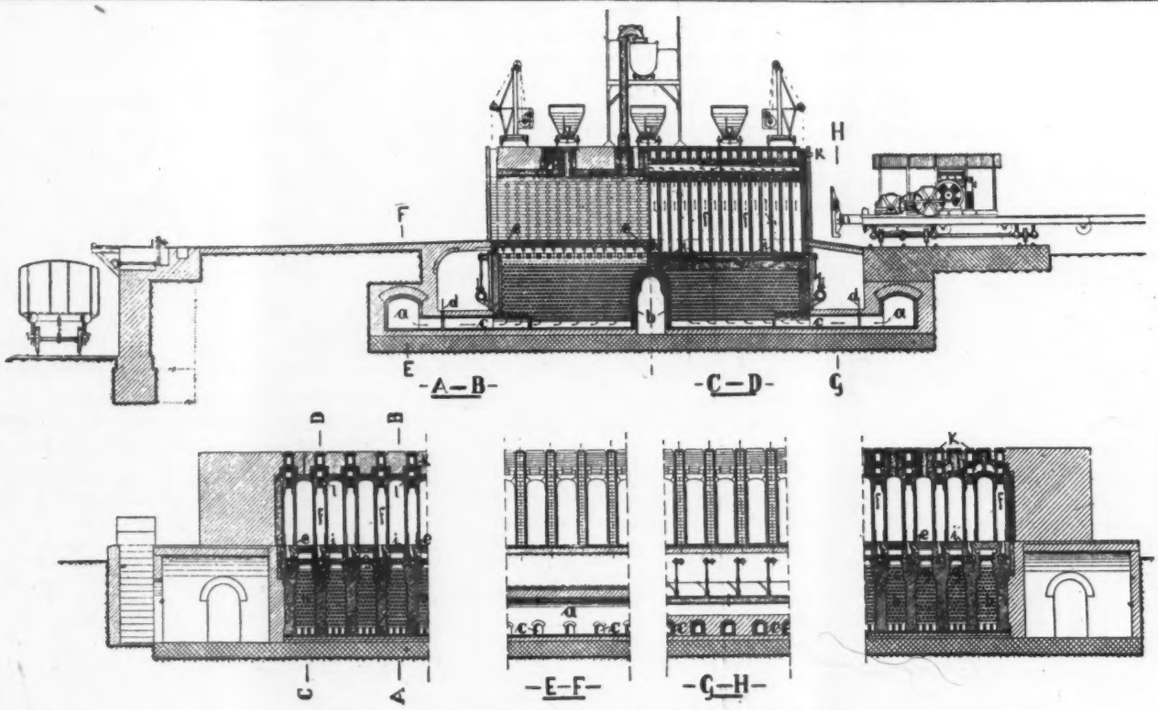

Fig. 2.—Koppers' Improved Regenerator Coke Oven—Patented 1905.

combines with the heating gas at a point on a level with the sole of the oven. The gas is delivered into the distributing channel *g*, and passes into the flues through the nozzles *i*. As the combustion in the flues has of necessity to be reversed at periods of about half-an-hour, the flues are so arranged that the combustion takes place in one period in the flues forming one-half of the oven wall, and in the next period in the other half of the oven wall. The gases of combustion pass up the heating flues on one side of the oven and down the heating flues on the other side, and are drawn into the regenerator by the chimney draught. The heat is abstracted by the checker firebrick work in the regenerators to such an extent that upon entering the chimney the temperature does not exceed 250° C. The reversal of the combustion is effected by hand or by automatic means. Similarly to the waste heat ovens, the nozzles are accessible through the openings in the superstructure, through which it is easily possible for the nozzles to be removed and substituted for others for regulating purposes. Each heating flue is furnished at the top with a sliding brick, which enables the heating to be regulated to a nicety, and so that a perfectly uniform heating of the oven walls is attained. In no other system has it been possible hitherto to obtain anything like such equality in the heating of the oven walls.

The gas from properly constructed ovens is of a perfectly uniform quality, and is exactly the same in character as that obtained from gas retorts. Gas is supplied for town illumination from a number of coke oven plants. The town of Essen is lighted by gas produced from the Koppers' coke ovens at the Victoria Mathias Colliery. This gas is of a very superior quality, notwithstanding that it is obtained from semi-bituminous coal. Similarly, the towns of Heinitz, Hutte, Homberg, Mahlstadt-Burbach, Rheinhausen, and the districts surrounding these towns are supplied with gas from coke ovens at neighboring colleries. Negotiations are now in progress at Recklinghausen for lighting this town by coke oven gas. In America, the city of Boston obtains its gas supply largely from coke ovens.

It is necessary in some cases, where the quality of the coal is poor, for the gases of distillation evolved in the first period of coking only to be used for illuminating purposes; but this is not needful with coal of ordinary coking quality. As will be seen from the following table, showing the analyses of different coals, the quality of gas obtained from coking coal is almost exactly the same as that from gas coal. From the best gas coal, especially if it contains a comparatively high percentage of oxygen, gas of no better quality or greater in quantity is obtained than from coal of poorer quality carbonized in coke ovens. The reason for this is to be ascribed to the heating of the retorts being wrong in principle. The retorts are heated on all sides, including the upper portion, which should remain cool; and the gases are to a great extent decomposed. The tar from coke ovens is always of pretty much the same consistency whatever kind of coal is employed, being of a very liquid nature, whereas tar in gas works frequently is so thick that it hardly runs at ordinary temperatures. In the more recent type of coke ovens, especially in that of the Koppers' patent design, the heating of the top part of the oven, where the gases of distillation are collected, is completely avoided, while the sole of the oven is not subjected to a high temperature. No decomposition of the gases therefore takes place. Another great advantage derived from this method of heating is that the yield of ammonia is very greatly increased. According to the quality of the coal, the yield of sulphate reaches the high figure of 1.5 per cent. per ton of coal. On an average, the nitrogen content in coke oven gas is from 30 to 50 per cent. more than that from gas retorts. This is of very great importance in connection with the production of sulphate.

Koppers' Patent Inclined Coke Oven.—(See Fig. 3.)—This illustration shows a battery of inclined coke ovens which are now under construction at the Bochum Gas Works. They are being built by Mr. Heinrich Koppers, of Essen, and are designed on the same principle as the coke ovens erected by the same patentee—practically the only difference being that they are arranged at an inclination instead of horizontally. It might be further mentioned that a battery of 15 similar ovens is now being erected by Mr. Koppers at the Vienna Gas Works. The principal features of the design are the facilities provided for inspection and regulation. The openings in the superstructure for inspection purposes and for giving accessibility to all the heating jets are of special importance, and distinguish the oven from all other systems, while the provision of the regulating sliding bricks over each heating flue is a feature of inestimable value, as these enable the heating of the ovens to be perfectly controlled, which, as already painted out, is not possible in any other system. The gas for heating the ovens is obtained from a gas producer, and is delivered into a distributing flue under the oven chamber, whence it passes into the 18 heating flues, where it combines with the heated air from the recuperators.

The gas producer is placed in front of the ovens and arranged in such a way that any movement that takes place owing to expansion and contraction will not affect the brickwork of the ovens. The heat is applied only at the lower part of the oven wall; being confined to about two-thirds of the height. The sole and the crown of the oven are not subjected to more than a very moderate heat. The two end flues of the oven by which the gases of combustion pass into the recuperators can be regulated. The heating flues require only to be regulated once—when the ovens are first set in operation—and do not subsequently require more than occasional adjustment. In order to economize the heat, one of the two waste gas flues can be throttled during the last 6 hours of the coking period, as it is well known that less heat is required for effecting carbonization during the latter period of coking than is necessary in the first period. A further

	Coking Coal.						Inferior Gas Coal.			Gas Coal.			Cannel Coal.
	Lean.			Rich.									
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
Ash..... per cent.	9.34	8.20	9.00	7.64	6.10	1.20	4.50	1.18	2.30	2.50	1.50	1.00	5.50
Yield of coke by crucible test "	84.80	81.50	80.00	76.16	78.00	72.30	71.40	73.70	64.60	63.10	66.70	66.64	64.40
Yield of coke by distillation test per cent.....	85.93	84.61	82.75	80.97	81.48	77.33	76.38	80.85	74.04	74.48	75.87	75.64	74.77
Yield of tar per cent..	1.37	2.16	2.75	1.22	2.50	1.70	3.35	1.65	2.92	2.73	2.21	2.55	1.85
Yield of ammonium sulphate per cent.....	0.96	1.05	1.27	1.28	1.26	1.30	1.35	1.26	1.53	1.29	1.52	1.50	1 46
Gas liquor per cent.....	3.43	3.10	3.08	4.32	3.62	6.14	5.15	4.08	6.57	5.42	5.47	5.36	4.30
H S per cent	0.27	0.15	0.58	0.31	0.19	0.25	0.37	0.13	0.34	0.14	0.17	0.17	0 70
CO_2 per cent	0.35	0.18	1.05	0.61	0.33	0.96	0.55	0.34	0.66	0.53	0.81	0.63	0 73
Gas per ton of coal without CO_2 and H_2S, at 0° C. and 760 mm	232.10	243.90	243.70	265.10	274.60	260.70	283.80	284.40	290.10	316.70	310.70	308.40	321.20
Do. do., at 15° C..	244.80	257.60	257.00	284.90	292.70	275.00	299.60	300.00	306.00	334 00	328.40	325.20	348.80
Gas per ton of coal with CO_2 and H_2S, at 0° C. and 760 mm.....	235.70	245.90	252.60	270.40	277.60	267.40	289.00	287.10	295.90	320.40	316.10	312.80	329 80
Do. do., at 15° C.....	248.40	259.60	266.00	279.60	289.70	281.70	304.80	302.70	311.80	337.70	333.80	329.70	357.50
Heating value of 1 cubic meter of gas:													
Steam Calories.....	4,351.40	4,547.60	4,539.10	4,910.50	4,731.10	5,007.60	5,055.90	4,803.30	5,051.50	5,230.10	4,948.50	5,144.20	5,565 80
Liquid "	4,962.00	5,064 00	5,161.10	5,571.30	5,386.20	5,659.10	5,705.80	5,452.50	5,695.00	5,882.40	5,587.00	5,789.50	6,249.60
Heating value of gas from 1 kg. of coal:													
Steam Calories.....	1,065.20	1,170.40	1,166.50	1,372.30	1,374.30	1,376.90	1,515.70	1,441.00	1,545 70	1,746.80	1,625.10	1,673.40	1,942 20
Liquid "	1,214.70	1,304.40	1,326.40	1,557.70	1,561.90	1,556.20	1,711.70	1,635.70	1,742.60	1,964.70	1,834.70	1,883.30	2,180 90
N_2 per cent.....	9.70	9.50	8.40	3.74	8.72	2.56	7.20	3.47	7.69	7.38	6.70	8.57	5.00
H_2 "	54.33	54.35	53.90	56.01	50.84	53.20	47.58	56.27	46.92	45.72	49.49	43.44	46 90
CH_4 "	30.77	30.55	31.10	32.65	33.94	33.04	35.72	31.97	34.99	35.40	33.23	37.09	36 10
C_mH_n "	1.20	2.00	2.20	3.40	2.50	3.60	3.80	2.80	4.10	5.20	3.92	4.00	7 00
CO "	4.00	3.60	4.40	4.20	4.00	7.60	5.70	5.50	6.30	6.30	6.66	6.90	5 00
Weight of gas "	8.65	9.80	9.88	12.57	11.88	13.63	14.20	12.95	15.18	16.80	15.47	15.65	17 65
Sp. gr. of gas "	0.35	0.39	0.38	0.44	0.41	0.49	0.46	0.42	0.49	0.46	0.40	0.47	0.50

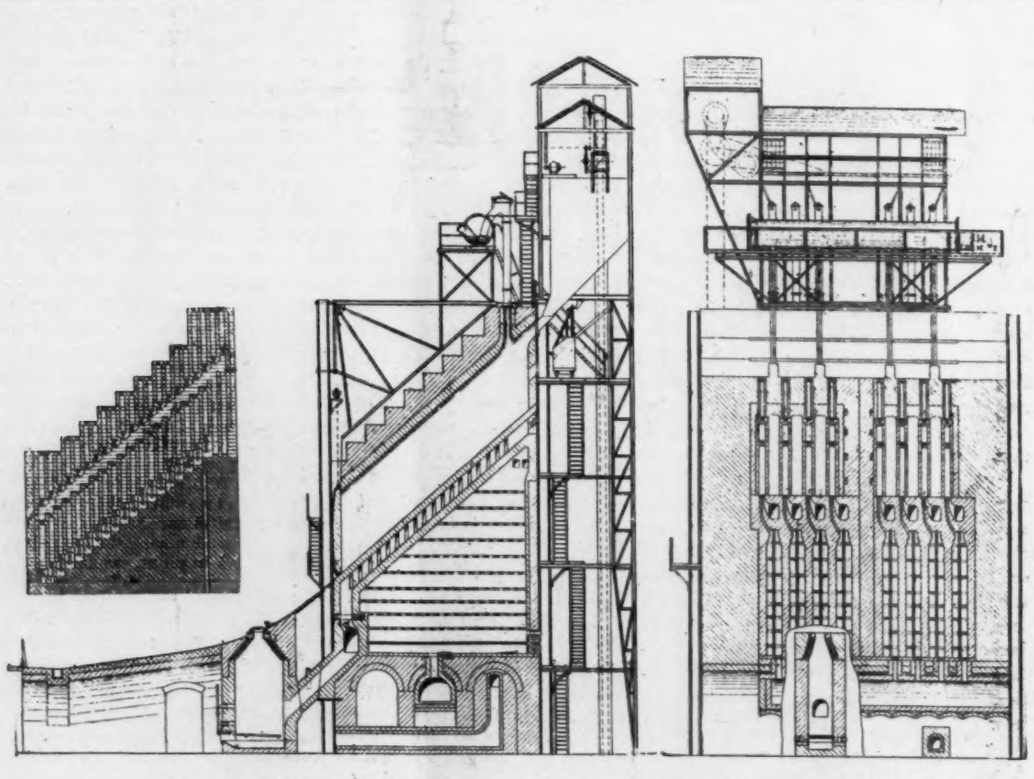

Fig. 3.—Koppers' Patent Inclined Coke Ovens, as Erected at the Bochum and Vienna Gas Works.

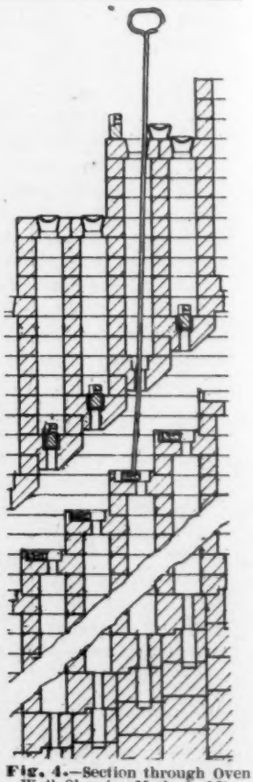

Fig. 4.—Section through Oven Wall, Showing Method of Regulating the Heating Flues.

feature of the arrangement is provision of means for diverting a portion of the hot air for consumption in the gas producer, whereby still further economy in the heating is attained.

The great advantages of the Koppers' ovens, and the extraordinary success which the ovens have enjoyed throughout the world, led the authorities of the town of Bochum to embark upon what may appear a venturesome undertaking. The exploiting of the new system by the Bochum Gas Works will undoubtedly be of great advantage to the gas industry, as the experience which has been gathered together by the coke industry, and which has been jealously kept secret by individual firms, will now be available for gas works in general. As a result, both the coke and gas industries will benefit, in that economy in cost and working and improvements in construction will all be gained through the mutual exchange of ideas. For this the Bochum authorities deserve the thanks of the community at large.

Improved Treatment of Gas Containing Ammonia.—The usual process for purification of the gases consists generally in subjecting them first of all to a cooling operation and then passing them through washers for the extraction of ammonia. The gases upon leaving the ovens pass through air and water coolers, in which the larger part of the tar and a portion of the gas liquor condenses. It is then drawn by an exhauster by which it is forced through tar extractors and ammonia washers. The ammonia washers are designed on several systems—some being of a revolving description, while others are

stationary and are not mechanically operated. The principle upon which they all work, however, is the same—viz., that the washing liquor passes through the washers in the opposite direction to the gas, so that the enriched liquor comes into contact with the gas rich in ammonia, and the weak liquor acts on the gas when freed of most of its ammonia. It is necessary, in order to obtain efficient washing, for the washing liquor to be of a soft nature and quite cool.

The difficulty of constructing water tight tanks, and of keeping them tight, and also the difficulty experienced in disposing of the effluent from sulphate works, has been the means of endeavors being made to dispense with the washing of the gases with water, and a system was brought out some years ago, the object of which was to bring the gas into direct contact with sulphur acid, in order to extract the ammonia without the scrubbing operation being necessary. This system only required a small collecting tank for the tar extracted in the hydraulic main, which was constructed of iron. By dispensing with the necessity for the employment of water for scrubbing (the provision of which at collieries in sufficient quantity and at a sufficiently low temperature was frequently a matter of difficulty) appeared to be a great advantage. The system consisted in conveying the hot gases having a temperature from 130° to 160° C. in pipes, carefully coated with non-conducting material, and forcing the gas by means of an exhauster direct into a sulphuric acid bath. The tar separated out and floated on the surface of the acid, whence it was skimmed or drawn off. The gas not having been subjected to any cooling operation, there were no products of condensation. As a consequence of this, the sulphate produced was contaminated with tarry matters, which spoilt its appearance and deteriorated its quality. The tar itself was detrimentally affected and was of an acid nature, it being necessary, in order to render it marketable, to purify it with hot water and to neutralize the acid with alkalies. It was also found that the saving in labor which was expected to be derived by the system was not realized owing to the great cost involved in producing and treating the sulphate. In order to extract the tar from the hot gas to overcome the difficulties referred to, the gases were passed through centrifugal extractors. These machines, almost without exception, possess the drawback that they extract only the constituents boiling at a high temperature, and as a result a product of a pitchy nature was produced instead of tar. This system, which has been carried out in connection with a number of coke oven plants, has proved very unsatisfactory.

The new system of Koppers' is designed on the same principle, but in this system the gases are freed from tar before they are passed into the sulphuric acid bath. The gas is first of all cooled, in order that the tar and gas liquor may condense. It is then passed through the tar extractor to take out the last traces of tar. After passing through the tar extractors, the gas is led back to the preliminary gas cooler, which is arranged as a heat exchanger and which heats up the gas to about 80° C. by the hot gases coming from the ovens. The gas heated up in this way, and freed of tar, is then conducted to the saturator, where the ammonia is extracted from the gas and recovered direct in the form of sulphate. From Fig. 5 a diagrammatical representation of the system will be seen.

The hot gases of distillation pass first into what is called a heat exchanger *A*, and thence are conducted into water coolers *B*, by which the temperature is reduced to the degree which is necessary for the extraction of tar. As in the ordinary system the gas, after cooling, is drawn by exhausters *C* and forced through the tar extractors *D*. After leaving the extractors, the gas is conducted to the heat exchanger *A*, where it becomes heated up and at the same time cools down the hot gas as it comes from the ovens. The heated gas is then taken direct to a saturator *E*, where it comes in direct contact with sulphuric acid. Here the ammonia is extracted, and is recovered in the form of ammonium sulphate. The gas, after being freed from ammonia, passes out of the saturator by the main *K*, by which it is conducted back to the ovens without necessitating any further cooling process which is necessary where the ordinary system is employed.

In the preliminary cooling process a large portion of the tar and of the gas liquor is condensed out of the gas. These products of condensation are conducted to the separating tank *H*, from which the tar overflows into the tar storage tank *I*, and the ammoniacal liquor passes into the storage tank *J*. The ammonia liquor is delivered to a distilling apparatus *G*, where the ammonia is driven off by means of steam and lime in the usual way. The vapor from the still containing the ammonia is conducted to the gas main, whence it passes with the gas into the saturator *E*.

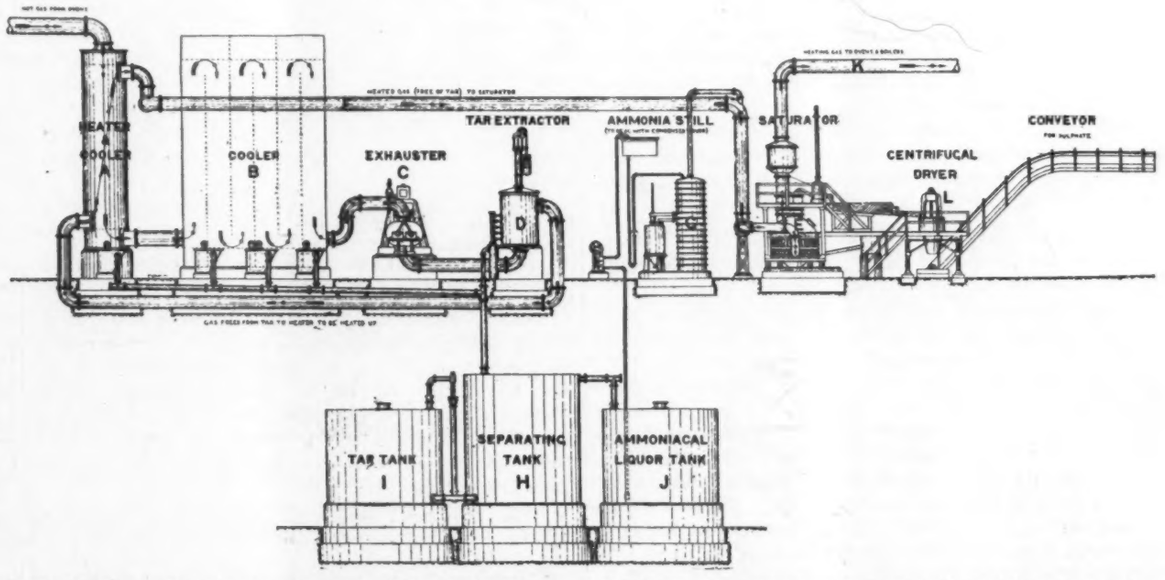

Fig. 5.—Koppers' Patent System of By-Product Plant for the Recovery of Sulphate Direct from the Gas.—(Gas Reheated by Hot Gas from Ovens.)

The sulphate formed in the saturator is collected in a well at the bottom, whence it is automatically removed by means of an injector, and then delivered into a centrifugal dryer *F*. The mother liquor extracted by the centrifugal flows into an intermediate vessel, whence it passes into the saturator. The acid is fed continuously into the saturator, and the liquor therefore is always maintained at uniform strength. The top portion of the acid in the saturator is hereby kept at a slightly acid state, which insures the ammonia being thoroughly extracted from the gas. It is only necessary for the gas to be heated before entry into the saturator to such a degree as will prevent condensation of the water vapor taking place in the saturator, so that the acid bath will not become diluted.

The dew point of gas produced in gas retorts is about 70° C., while in coke oven gas the dew point is about 80° C. This is owing to the coal used in gas works being practically free from moisture. The coal used in coke works contains, on the other hand, a comparatively large percentage of water. It has been ascertained by actual experience that it is not necessary for the gas to be heated to a higher temperature than 80° C. before it is passed into the saturator. At this temperature it has been found that the sulphate is easily and efficiently formed. The ordinary method of producing sulphate requires the temperature of the acid bath to be maintained above 100° C. in order to prevent the steam from the still condensing in the

saturator. The reduction of the temperature in the bath insures the complete combination of the ammonia with the acid, as the lower the temperature the greater the affinity between the acid and the ammonia. At 140° C. the sulphate melts, and even at a much lower temperature it becomes decomposed.

The advantages of the new system are as follows:

1. A considerable saving in steam is effected, owing to the great reduction in the quantity of liquor which has to be distilled. A well designed ammonia still requires 300 kg. of steam to treat 1 ton of gas liquor. The cost of steam in gas works can be taken at 50 cents per ton as a minimum.

2. No water being required for scrubbing purposes, a saving is, therefore, effected in this direction.

3. The quantity of liquor required to be distilled being greatly reduced, the effluent from the still is reduced correspondingly, which is a great advantage where difficulty is experienced in disposing of this liquid.

4. The gas in passing through the acid bath becomes freed of all the alkaline matter it may contain. As a consequence of this, the destructive elements which are the cause of the corrosion of gas meters, etc., are eliminated, as sulphuretted hydrogen and cyanogen combine with ammonia only in the presence of traces of alkalies.

5. The design of the plant is very greatly simplified.

6. The ammonia washers being dispensed with, no pumps are required for dealing with the scrubber liquor. Steam is hereby saved, and also labor, which would otherwise be necessary for attending to the washers.

7. The difficulties which have frequently to be contended with in the ordinary system, owing to depositions of naphthaline throughout the plant, are entirely done away with, and stoppages on this account are, therefore, not to be feared.

8. The heavy hydrocarbons contained in the gas are not affected in the slightest by the acid, so that no loss will be occasioned in this direction; while, furthermore, the calorific value of the gas remains unchanged.

The saving which would be derived by the new system can be taken at about 8 cents per ton of coke produced. The important advantages of it are, therefore, of the greatest moment to the gas industry. Very costly appliances are dispensed with, as besides the scrubbing apparatus not being required, the liquor storage tanks can be made of much less capacity. The continual outlay for fresh water for scrubbing purposes is saved. The space required for the plant is much smaller than is necessary for the usual system, which results in considerable economy in the cost of building work. All these advantages should appeal to town gas authorities and induce them to introduce the new system. If only on account of the naphthaline trouble being avoided, the new plant should be viewed with favor. The new system has been carried out on a large scale for dealing with 100,000 cubic meters of gas per 24 hours and has proved a great success, so that its adoption would not be attended by the slightest risk.

The writer hopes that this communication will meet with the approval of gas engineers, and that it will lead to the subject being thoroughly inquired into, in which case he feels perfectly confident that it will result to the great advantage of the gas industry.

The Case of Boerth against the Detroit City Gas Company, Circuit Court, Wayne County, Mich.

This is an opinion from the Circuit Court, Wayne County, Mich., which action was brought by H. J. Boerth, of Detroit, who sought to prevent the Detroit City Gas Company from cutting off his gas supply. Complainant sought relief from the decision of a lower court sustaining defendant in its act. The history of the case, as printed in the *Detroit Legal News*, is appended:

The right of the City of Detroit to regulate the price to be paid by consumers of gas, passes as an incident to the authority of the municipality to attach conditions to its consent that pipes may be laid in the streets, under the charter provision giving the municipality control over its streets. Such rates may be fixed by contract between the municipality and the gas company, and is not an attempt by the municipality to regulate rates by the exercise of legislative power.

A municipal ordinance providing that a gas company "shall not charge nor receive a higher rate than 90 cents per 1,000 cubic feet of gas," etc., is a grant of the right to charge not to exceed such price and not a limitation upon the right to charge.

One who pays a price provided by ordinance for illuminating gas used for fuel cannot seek relief from such charge on the ground that the company sells gas to be used in gas engines at a lower rate. Such discrimination affords no right to relief unless the consumer of fuel gas is unjustly discriminated against, or gives the user of gas for gas engines an undue advantage.

Appeal from the Circuit Court for Wayne county in chancery, Flavius L. Brooke, judge.

Bill filed by Henry J, Boerth against Detroit City Gas Company. From the decree entered, complainant appeals—Decree dismissing the bill affirmed.

Alex. J. Groesbeck and Guy A. Miller ior complainant and appellant.

Angell, Boynton, McMillan & Bodman for defendant and appellee. (Brennan, Donnelly & Van De Mark, of counsel.)

Before McAlvay, Carpenter, Montgomery, Ostrander and Hooker, justices.

The complainant keeps a restaurant in the city of Detroit. In the month of October, 1901, he used for fuel purposes in said restaurant gas supplied by defendant to the amount of 113,700 cubic feet. Defendant presented a bill charging complainant for said gas at the rate of 80 cents per 1,000 cubic feet. Complainant tendered compensation at the rate of 60 cents per 1,000 cubic feet. This tender defendant refused and threatened to remove complainant's meter and discontinue his supply of gas. Thereupon complainant instituted this suit in equity for the purpose of securing a permanent injunction restraining such removal. He contends that the rate charged by defendant is at once unreasonable and unjust discrimination. He was not permitted to introduce testimony tending to prove the charge unreasonable, because the trial court held that the city of Detroit had entered into a valid contract permitting defendant to make a charge of 80 cents per 1,000 cubic feet for the gas furnished complainant. This contract was found in an ordinance of the city made in 1898 granting to defendant for 30 years the right to lay its gas pipes in the streets of the city, and is as follows:

"The said company (defendant) shall not charge nor receive a higher rate than 90 cents per 1,000 cubic feet for manufactured gas sold to consumers for fuel purposes from illuminating mains within the city limits, and each and every consumer shall be entitled to a discount of 10 cents per 1,000 cubic feet upon prompt payment."

Complainant claims the rate charged to be an unjust discrimination because defendant supplied gas for power purposes to those who use gas engines in the city of Detroit at the rate of 60 cents per 1,000 cubic feet. This claim, like the claim of unreasonableness, was denied by the trial court and a decree entered dismissing complainant's bill. Complainant appeals to this court. He asserts three propositions, and if he is right respecting any of them he is entitled to relief. Those propositions are:

1. That the city of Detroit had no power to grant to defendant the right to charge 80 cents per 1,000 cubic feet for fuel gas furnished to consumers.

2. That the city of Detroit never did grant the right to make that charge.

3. That the making by defendant of the 60-cent rate to those who use gas for power purposes was unjust or unlawful discrimination entitling complainant to relief.

Carpenter, J. (After stating the facts).—Did the city of Detroit have authority to grant defendant the right to charge 80 cents per 1,000 cubic feet for fuel gas delivered to consumers within said city? The charter of the city of Detroit confers upon it this power: "To control, prescribe and regulate the manner in which the highways, streets, lanes, alleys and public grounds and places within the city shall be used and enjoyed. To provide for and regulate the lighting of said avenues, streets and public places." The act for the organization of gas light companies—under which act the defendant is incorporated—contains the following provision: (Section 7,123, Comp. L.)

"Any corporation formed under this act shall have full power to manufacture and sell gas and shall have power to lay conductors for conducting gas through the streets, lanes, or squares of any city, town or village where said corporation is located or carrying on its business, which pipes or conductors shall be laid with the consent of the municipal authorities of such cities, townships or villages through which the same are laid under such reasonable regulations as they may prescribe."

There is given by this language to the city of Detroit very broad powers. Without its consent a gas company cannot lay its pipes in the streets, and without so laying them it cannot furnish gas to the inhabitants of the municipality. The city may refuse to grant that

consent. It is clear, too, that it may attach conditions to its consent. What conditions? May it prescribe the rates at which gas shall be furnished to its inhabitants? The statute does not say in express terms that it can. Is it forbidden? It certainly is not forbidden in express terms. The only language in the statute limiting the authority of the municipality is to be found in the language authorizing the municipality to prescribe reasonable regulations for the laying of the pipe. Without undertaking to definitely determine what is meant by reasonable regulations, it is quite clear that nothing but unreasonable regulations are prohibited. Authority to prescribe rates, then, is not prohibited unless that authority may be properly denominated unreasonable. Is it unreasonable? There is no doubt that the municipality may determine for what length of time a gas company may use its streets for conveying gas. It had, therefore, authority – an authority exercised in this case to determine that the gas company should use the streets for a period of 30 years, for the purpose of supplying its inhabitants with gas. Is it unreasonable for the city to prescribe the rates at which gas shall be furnished to its inhabitants? If the city cannot prescribe those rates, consumers of gas must pay whatever price the gas company asks or resort to litigation, and pay what is there determined to be reasonable. Few consumers will resort to litigation. Indeed, gas bills are generally so small that it does not pay to question their amounts. If the rates are not prescribed it may be safely stated that nearly all consumers of gas will pay without question whatever bills are presented to them. This is illustrated by Pingree vs. Mutual Gas Company, 107 Mich., 156. There it appeared that for many years the Mutual Gas Company, of Detroit, had charged an excessive amount for the gas it furnished. It is a fair inference that not one of its thousands of consumers questioned these bills for years. Indeed, the plaintiff in that suit, the late Governor Pingree—a man not likely to submit to illegal extortion—himself paid these bills without protest, and the only question in the case was whether that circumstance disentitled him to recover. As a practical proposition it may be said, then, that consumers must either pay the rates fixed by the company or the rates prescribed by municipal authority - in the absence, as in this case, of any action by the legislature. It may be said then that in order to safeguard the rights of its inhabitants who use gas, it is not only not unreasonable that the city should have the power to fix rates, but it is highly expedient—indeed, it is necessary that it should possess that power. It is therefore quite clear that there is nothing in the statute which either in express terms or by proper construction prohibits the city prescribing rates at which gas shall be furnished to its inhabitants.

In this respect the case at bar differs materially from Freeport Water Company vs. Freeport, 188 U. S., 587, a case relied upon by complainant. In that case it was held by a divided court that the authority of the municipality to enter into a contract which prescribed water rates was limited by express statutory enactment. There is no such limitation in this case.

It has already been stated that the statute does not give the city express authority to prescribe rates. Can that authority be implied? Does it pass as an incident to the authority to attach conditions to its consent that pipes may be laid in the streets? This raises the most important question in this case. Complainant contends that the power of a municipality to prescribe rates cannot rest in implication. That a municipality has not that power unless it is expressly granted. In support of this contention are cited many cases (Interstate Commerce Commission vs. Railroad Company, 167 U. S., 479, is the most important of these cases) relating to a grant of the legislative power of determining rates. The principle underlying these authorities is that there is a strong presumption against the grant of legislative authority. That principle and the authorities applying it have no application here. It is not contended that the city of Detroit has the legislative power of determining rates. That would be the power of regulating these rates according to its own wisdom from time to time precisely as the legislature regulates the rates of railroads. Complainant agrees with defendant that the city possesses no such power. The power to prescribe rates by contract—and that is the power which was exercised in this case - is a very different power from the legislative power of regulating rates.

Says the Supreme Court of Indiana in City of Indianapolis vs. Gas Light and Coke Company, 66 Ind., 396:

"This power to legislate within the authority delegated to them by law is distinct from the power to contract, although exercised by the same corporation. They cannot by contract delegate or restrict their legislative power, nor can they, merely by their legislative power, make a contract. These two powers need not be confounded. The exercise of the legislative power requires the consent of no person except those who legislate; while it is impossible to make a contract without the consent of another, or others. We think, therefore, that, when the city of Indianapolis made the contract in question with the Gas Light Company (a contract like that involved in this case) it made it in the exercise of its power to contract, and not in the exercise of its power to legislate, although the power to make the contract was authorized by an ordinance; and, having the power to make a contract touching the subject matter, it had the right to make it according to its own discretion as to its prudence or good policy, within the limits of its franchise."

Says the United States Circuit Court of Appeals, Eighth Circuit, in Illinois Trust and Savings Bank vs. City of Arkansas City, 76 Fed. R., 271:

"A city has two classes of powers—the one legislative, public, governmental, in the exercise of which it is a sovereignty and governs its people; the other, proprietary, quasi private, conferred upon it not for the purpose of governing its people, for the private advantage of the inhabitants of the city and of the city itself as a legal personality. In the exercise of the powers of the former class it is governed by the rule here invoked. In their exercise it is ruling its people and is bound to transmit its powers of government to its successive sets of officers unimpaired. But in the exercise of the powers of the latter class it is controlled by no such rule, because it is acting and contracting for the private benefit of itself and its inhabitants, and it may exercise the business powers conferred upon it in the same way, and in their exercise is to be governed by the same rules that govern a private individual or corporation. * * * In contracting for water works to supply itself and its inhabitants with water, the city is not exercising its governmental or legislative powers, but its business or proprietary powers. The purpose of such a contract is not to govern its inhabitants, but to obtain a private benefit for the city and its denizens." See also Omaha Water Company vs. Omaha, 147 Fed. R., 1; Muncie Natural Gas Company vs. Muncie, 160 Ind., 97; Zanesville vs. Gas Light Company, 47 Ohio St., 1.

Complainant invokes the authority of those cases (see Street Ry. Co. vs. City of Detroit, 110 Mich., 38; same case, 171 U. S. 48) which hold that the power to grant exclusive rights will not be implied from general language, but must be clearly and explicitly expressed. Nothing can better show the inapplicability of these decisions than by quoting the concluding language of the opinion rendered by the Supreme Court of the United States. It reads as follows:

"Easements in the public streets for a limited time are different and have different consequences from those given in perpetuity. Those reserved from monopoly are different and have different consequences from those fixed in monopoly. Consequently those given in perpetuity and in monopoly must have for their authority explicit permission, or, if inferred from other powers, it is not enough that the authority is convenient to them, but it must be indispensable to them."

Complainant has cited many other authorities. They have received our careful attention. None of them are in point. We can say of them as of those discussed in this opinion, that they justify no argument helpful to complainant except upon the assumption that the power to prescribe rates cannot be used in the interest of the inhabitants of the city. We have already shown it can be used to safeguard the interest of those inhabitants. Emphasis is placed upon the proposition that the rates prescribed by the ordinance are too high. This does not afford an argument against the existence of the power to prescribe rates. In Mahan vs. Michigan Telephone Co., 132 Mich, 242, the telephone company sought to avoid certain rates for telephonic service prescribed in a contract entered into by its predecessor and the city. It is apparent that the company thought the prescribed rates were too low. It was held that these rates governed. Surely the principle is not changed because a different "ox is gored."

Concluding as we do that none of the authorities relied upon by complainant justify the proposition that the city of Detroit had not the implied authority of prescribing rates by contract, we proceed to consider opposing authorities. These authorities are so clear, authoritative and harmonious that we shall not enter into a discussion of the principles governing the implied powers of municipalities. Though it should be borne in mind that, as already pointed out in this case, the power of a municipality to prescribe rates by which gas shall be furnished is a power necessary to safeguard the rights of its inhabitants.

The first case to receive attention is Mahan vs. Michigan Telephone Company, heretofore alluded to, reported in the 132 Mich., p. 242. There the city of Detroit possessing not the authority to exclude telephone companies from the use of its streets, but possessing only the authority to establish reasonable rules and regulations, enacted an ordinance fixing the maximum rate of telephonic charges. The telephone company accepted this ordinance. The successor of this telephone company declined to observe the terms of this ordinance. It denied the right of the city to fix rates. This contention was over-

ruled and it was said "the right of the city to make the contract in the premises cannot be questioned."

In Muncie Natural Gas Company vs. Muncie, 160 Ind., 97, it was held that the grant of an exclusive power over the streets, highways and alleys gave to the municipality authority to enter into a contract with the gas company prescribing the rates which should be charged. The court saying:

"The grant of exclusive power to the Common Council over such ways comprehends the right to permit gas companies to use the streets. If the Common Council may permit a natural gas company to use the streets without any conditions annexed, except such as the law attaches, it is not perceived why, as in this case, in making provision for supplying natural gas to all of the inhabitants of the city, it may not protect such inhabitants against extortion by providing that the company shall not charge in excess of certain prices for its service. The right to annex terms by way of limitation upon the authority of the grantee in such cases has been often affirmed by this court."

Under a provision that a street railway shall not be constructed until the Council "by ordinance shall have granted permission and prescribed the terms and conditions," it was held that the city might enter into a contract prescribing the rates of fare. Cleveland vs. Cleveland St. Ry. Co., 194 U. S., 517. See also Noblesville vs. Noblesville Gas Co., 157 Ind., 162; Western Paving Co. vs. City St. Ry. Co., 128 Ind., 531; City of Indianapolis vs. Consumers Gas Trust Co., 140 Ind., 107; Zanesville vs. Gas Light Co., 57 Ohio St., 1; Cleveland vs. Cleveland Ry. Co., 201 U. S., 529; Omaha Water Co. vs. Omaha, 147 Fed. R., 1; Detroit vs. Detroit St. Ry. Co., 184 U. S., 368.

We conclude, therefore, that the city of Detroit did have authority to enter into the contract prescribing the rate which defendant should charge the inhabitants of the city of Detroit.

2. Did the city of Detroit enter into such a contract? Did it grant to defendant the right to charge 80 cents per 1,000 cubic feet for gas used for fuel? That depends upon the proper construction of the following language:

"The said Company (defendant) shall not charge nor receive a higher rate than 90 cents per 1,000 cubic feet for manufactured gas sold to consumers for fuel purposes from illuminating mains within the city limits, and each and every consumer shall be entitled to a discount of 10 cents per 1,000 cubic feet upon prompt payment."

Complainant argues that this language is a limitation upon the right of the Company to charge and not a grant. This precise question was involved in Detroit vs. Detroit Citizens' St. Ry. Co., 184 U. S. 368. There an ordinance provided "that the rate of fare shall not exceed 5 cents on any one car." The court said:

"Nor does the language of the ordinance, which provides that the rate of fare for one passenger shall not be more than 5 cents, give any right to the city to reduce it below the rate of 5 cents established by the Company. It is a contract which gives the Company the right to charge a rate of fare up to the sum of 5 cents for a single passenger, and leaves no power with the city to reduce it without the consent of the Company." See also Cleveland vs. Cleveland St. Ry. Co., *supra*.

A similar question was involved in Pingree vs. Michigan Central Railroad, 118 Mich., 314. There the charter of the railroad company provided that it should be lawful for said Company from time to time to fix, regulate and receive the tolls and charges to be taken for the transportation of property and persons on the road subject, only to a limitation as to passengers of 3 cents a mile, and 10 cents in addition on distances not exceeding 30 miles. It was held that this gave the Company a contract right to make any charge not in excess of the amount specified, and that this right could not be abridged by subsequent legislation nor authorized by the charter. In opposition to these views, complainant relies upon a line of cases of which Georgia Bank Co. vs. Smith, 121 U. S. 179, is an illustration, which hold that similar language to that under discussion inserted in a statute does not prevent subsequent legislation reducing the charges. Those cases are not applicable. None of them are authorities for the proposition—and that is the proposition involved in this case - that before the enactment of such subsequent legislation, the rates prescribed in the statute could be enforced. Indeed, it is our understanding that all these cases proceed upon the theory that the prescribed rates governed until they were changed by legislation, We are therefore of the opinion that the ordinance under consideration gave defendant a right to charge 80 cents per 1,000 cubic feet for gas used for fuel.

3. Did the making of a 60-cent rate to those who used gas engines constitute an unjust or unlawful discrimination entitling complainant to relief? Defendant does discriminate in its charges for gas. It charges those who use gas for illuminating purposes 90 cents per 1,000 cubic feet; those who use it for fuel purposes, 80 cents per 1,000 cubic feet; those who use it for power, 60 cents per 1,000 cubic feet. The discrimination between the use for illuminating purposes and fuel purposes was authorized by the ordinance of the city of Detroit. The discrimination between the use for fuel purposes and the use for power purposes was not authorized by that ordinance. The ground of that discrimination is this: That those who use gas for power purposes use on average much more than those who use it for fuel purposes, and that if they could not get it at the reduced rate they would use some other material for the purpose of creating power. Counsel for each party have elaborately briefed the question of the lawfulness of this discrimination. We shall not, however, undertake to decide that question. It is not neeessary to decide it in order to determine this case. The question is not likely to arise again, for since this suit was commenced a new ordinance has been passed by the city of Detroit authorizing that discrimination.

We do not undertake to decide the unlawfulness of the discrimination in question, because in our judgment it affords no ground upon which complainant is entitled to relief. Complainant is not entitled to relief because the rate of 80 cents per 1,000 cubic feet is too high, for that was the rate which defendant was entitled to charge. His claim for relief must rest upon the ground that the rate charged those who used gas for power purposes is too low. He cannot complain of this unless he is in some way injured. The circumstance that a manager of a public utility is granting unlawful favors to one of several individuals—and we do not decide that that was done in this case—does not give a right of action to every member of the community. That is a grievance to be redressed by the public. On principle it cannot be redressed by an individual unless he is specifically aggrieved thereby. As was said in Hays vs. Penn. Co., 12 Fed. Rep., 309: "It may be said that it is only where the discrimination inures to the undue advantage of one man in consequence of some injustice inflicted on another that the law interferes for the protection of the latter." See also Hosier vs. The Caledonian Ry. Co., 17 Sess. Cases (2d series), 302.

The users of gas engines who received the reduced rates were in no just sense competitors of complainant. The reduced rates gave them no undue advantage over him. They did not injure him. They therefore afford no ground upon which he can claim relief. The decree dismissing complainant's bill is affirmed.

Lightning Phenomena.

By E. E. F. Creighton, in *Elec. World*.

It is the object of this paper to give a general review of several of the more important results of the study of lightning phenomena and electrical surges obtained by the writer during the past year. These studies involved the construction of special apparatus which were described in a paper written for the American Institute of Electrical Engineers, June, 1908. The tests were made on the transmission system of the Animas Power and Water Company, at Silverton, Col. The records indicate that the storms are as frequent and severe over this system as any place known. The altitude of the lines ranges from 8,000 feet to 13,000 feet. There are four line potentials, namely, 43,500, 17,000, 2,300 and 440 volts, and the lines cover a large territory.

A subsequent article will deal with the aluminum arrester, which is the only known means of protection against continual electrical surges on transmission lines. These articles are condensations and revisions of lectures and of an article in the *General Electric Review* for June, 1908.

A third article will give a *résumé* of measurements of earth contact resistances and cement resisters and recommendations for the protection of buildings.

Lightning Phenomena.—The five principal factors studied in the Colorado tests were: Duration of surge of lightning, potential values of the lightning, maximum current discharge rate, natural frequency of the lightning, and quantity of electricity in the lightning stroke.

The Duration of Lightning.—The duration of lightning on the transmission line was measured by means of a spark gap in front of a rapidly revolving photographic film. Out of three dozen discharges, the usual duration of a single stroke was in the neighborhood of one one-thousandth of a second. The longest single stroke of induced cloud lightning recorded was 0.04 second. The actual duration of the usual stroke of cloud lightning is known from many observations to be comparatively short. A fairly authentic record of one stroke of the order of a half second has been made. Such a

length of duration, however, is rare, and careful measurements seem to indicate that such a duration is only the effect of multiple strokes, or successive discharges from the clouds.

In certain classes of storms the successive strokes take place slowly enough to be observed visually. They seem to be due to the readjustment of potential between clouds. For example, a cloud discharges and releases the potential strain in its neighborhood. The static electricity which, up to this time, had been distributed over the face of the adjacent cloud next to the earth or other oppositely charged clouds, is now drawn through the high internal resistance of this cloud toward the one which has just discharged and has been reduced to earth potential. It seems that this readjustment in the non-discharged clouds requires an appreciable time. Finally the static strains between this cloud and the one discharged is sufficient to cause a cloud-to-cloud discharge, which readjusts temporarily the potential in this locality but causes another stroke to earth. This process is repeated indefinitely until all the clouds in the neighborhood have readjusted their potentials with the original discharging cloud.

There is another consideration of duration of lightning which comes under the head of continual surges. Continual surges usually occur from an internal source. The usual cause is the grounding of a phase through an arc. The duration of this kind of discharge depends entirely upon the circumstances. So long as the arc to ground takes place there will be surges more or less severe according to the local conditions, which will continue until the trouble is removed from the line. During the measurements last summer aluminum lightning arresters were in operation continuously for periods ranging from 40 seconds to a half hour.

Potential Values of the Lightning.—The maximum potential value that a lightning charge can have on the line will result from a direct stroke. The usual effects of a *heavy* direct stroke are well known—the lightning jumps over the insulators and down the poles to the earth. If the stroke is not heavy enough to jump over the insulators to the earth, then it will spread over the line and the lightning arrester has an opportunity to carry the discharge to earth. These induced potentials may have all values ranging from the spark voltage from line to ground down to insignificant values. The observations of last summer show conclusively that the potential on the line nearest the clouds is the peak value, and when the charge is freed it spreads gradually over the line, giving at every point a lower potential. If there were no resistance in the path of the complimentary charge on the surface of the earth, this high peak of potential would travel undiminished in a wave along the line to the end. If the storm occurs at the station the lightning arrester in the station must take care of this excessive peak potential. The difference in the requirements to discharge under these two conditions of nearness or distance of the lightning storm really comes under the consideration of the maximum current discharge rate.

In connection with the subject of the arcing at the insulators, a digression in this discussion is made to describe some tests which gave concrete figures on the value of a wooden cross-arm relative to a metal cross-arm as an extra protection against cloud lightning. On a wooden cross-arm were arranged two porcelain tubes holding wires 1.7-inch above the surface of the wood and 10 inches apart. On the upper surface of the wood either tinfoil or a wet towel was placed in imitation of line conditions. The first test on this cross-arm was made on a 60-cycle circuit with a needle gap in parallel with the cross-arm. The spark e.m.f. of 47,000 volts was the same for either the tinfoil or wet towel on the cross-arm. On the contrary, when a sudden disruptive potential was applied, the wet wooden cross-arm had a breakdown potential 160 per cent. as great as the metal cross-arm.

Maximum Current Discharge Rate.—If only generator frequency is considered the rate of discharge is controlled principally by the resistance in series, but when frequencies of lightning, of thousandths of cycles per second, are considered, the line inductance plays an important part in limiting the discharge rate of lightning. In the discharge of a lightning arrester the maximum possible current will occur when the resistance is zero. This current may be expressed by the simple formula $Im = V\sqrt{\frac{C}{L}}$ where C is either the capacity per unit length of the line, or the total capacity of a condenser, and L is correspondingly the inductance of a unit length of line, or the concentrated inductance in a coil. In the high frequency circuit in the laboratory the maximum current is 0.03 ampere per volt impressed; consequently, at the value of 100,000 volts impressed, the maximum possible rate of discharge is 3,000 ampere. The value of current is actually somewhat less than this on account of the resistance of the circuit and the spark. On transmission lines the maximum possible current of a discharge coming from a distance out on the line is of the order of 0.602 ampere per volt impressed. Therefore, in order to produce a current of 10 amperes the impressed potential of lightning would have to be 5,000 volts—10 amperes is the current limitation at double normal voltage of some of the old types of arresters. In order to get a current discharge of 1,000 amperes, the applied potential must be at least 500,000 volts. This is the value of current discharge of the aluminum arrester at double normal voltage.

If, however, the lightning cloud is above the station or arrester, then the maximum possible rate of discharge may be somewhat greater than the value given above, on account of the fact that the average inductance of the line wire in the path of the discharge is less than in the previous case considered. Furthermore, it has already been noted in the paragraph on potentials that the maximum potential of the lightning is invariably greatest under the discharging cloud; consequently the rate of discharge of the arrester must be greater on account of the higher induced potential.

The Natural Frequency of Lightning.—The frequency of lightning may be considered under four heads:

(1.) The frequency of occurrence of the lightning stroke. For example, lightning strokes often come into a station during a storm at an average rate ranging from two per minute to one in five minutes.

(2.) Each of the flashes that appear to the eye as a single flash is often several distinct strokes distributed over a fraction of a second.

(3.) Each individual stroke may be analyzed into frequencies of the order of the natural frequency of the line. This was done in the Colorado tests by means of a rapidly revolving film in front of a spark-gap. The records show the frequency distinctively by the broken line; each part of the broken line corresponds to a half-cycle of the spark between the transmission wire and ground. There was no generator connected at the time of the test.

The accuracy of measurement is not high, so that the frequencies recorded are divided into seven groups. One stroke at 840 cycles per second, eight strokes at about 1,400, six strokes at about 2,000, two strokes at about 2,500, 20 strokes at about 3,000, and one stroke at about 4,000.

(4.) There is possible also a still higher frequency than the one just described. This frequency corresponds either to the line oscillating in segments or to a high frequency induced on the line by the natural high frequency of the cloud lightning.

In order to prove that this high frequency exists on the line, a special form of high frequency meter was designed, working on the principle of interference of traveling waves, or, in other words, stationary waves. This instrument had a number of coils resembling the pipes of a church organ, each one responding to its individual frequency and over tones. Due to the initial experimental difficulties with this apparatus and the natural condition of discharge on a long line, only two of the many records taken were of value. Both of these records show frequencies of the order of a million cycles per second.

Quantity of Electricity in the Lightning Stroke.—By means of fuses and the duration meter, the quantity of electricity to blow a fuse can be found. Its value $Q = \sqrt{\frac{Jt}{R}}$ where J is equal to the energy in joules necessary to raise 1 cm length of fuse metal to its melting point, t is the duration of discharge and R is the resistance in ohms per centimeter length of fuse metal. The joules of energy necessary to melt the fuse can be found by calculation of the metal used, or by actual calibration by the use of an oscillograph. The average effective quantity of lightning (q) passing through a fuse is equal to Q divided by the number of oscillations shown by the revolving film. If the oscillations are few in number, this calculated value is approximately equal to the original quantity on the line freed by the cloud discharge.

Reclassification.—Summarizing some of the essential parts of the foregoing discussion we have: That the strain on the lightning arrester will depend on the size of the storm cloud, the nearness of the cloud to the line, the distance of the storm away from the arrester, the resistance of the surface of the earth, the condition of the multiple stroke and the time elapsing between them, and the condition of continual surges. The effects of these factors may all be grouped under three heads:

(1.) The spark potential of the arrester. The arrester must be capable of sparking over at a voltage which is within the safe value of the insulation.

(2.) The factors which relate to the rate of discharge of the arrester. After the spark is established, the arrester must have a resistance low

enough to discharge the maximum rate of current that could flow to that point.

(3.) The factors which relate to the duration of the discharge of the arrester. It should have a duration sufficient to discharge so long as the potential is dangerously high. This factor is of paramount importance.

For many years the presence of continual surges on a transmission line was not fully understood. Lightning arresters were designed *per force* for transitory lightning. The multigap arrester is distinctly a transitory lightning arrester. It cannot be expected to carry the discharges which occur on a system from continual surges. With the graded shunt resistance on the multigap arrester, light discharges may be taken through the high resistance for an appreciable time, but through the low resistance the amount of energy dissipated is large, and consequently the duration of the discharge must be correspondingly small.

Occasionally, through a broken insulator, a transformer bushing, or a switch bushing, one wire of a non-grounded neutral system will become grounded through an arc. The arcing ground will send a series of surges throughout the entire system. It is necessary to have a lightning arrester on the circuit which will discharge the abnormal voltage for a time long enough to permit the operator to locate and isolate the trouble.

The aluminum arrester is the only one having inherently the qualities which permit a design to carry discharges continuously for any length of time desired, without appreciable loss of energy and still allow a heavy discharge of lightning.

A description of the aluminum arrester, together with a discussion of its characteristics, will be given in a subsequent article.

Weaving Concrete Pipes and Poles.

The *Gas World* says the uses to which reinforced concrete is applied are becoming more and more numerous every day, and there seem no bounds to the range of its utility. The latest development in the application of this materlal is the weaving from it of hollow poles and piles, pipes, etc. Hitherto workers in this material have almost entirely confined themselves to solid work, for the difficulty of adapting reinforced concrete to tubular constructions is obvious even to the layman. Moulds have been tried, but with moulds a great desideratum—the maintenance of control over the reinforcing material—is lost, and with it the certainty of having the reinforcement accurately imbedded in the concrete. Further, the application of force to the concrete to compress it is likely to alter the position of the reinforcement. These difficulties have been entirely eliminated from the problem by the ingenuity of Mr. Hans Siegwart, of Lucerne. His process of manufacture has been introduced into England by Messrs. Siegwart, Ltd., 1 Great Chapel street, Westminster, London, and recently a demonstration of the work of the machine was given at the works of Messrs. W. Cubitt & Co., 260 Gray's Inn Road, London, England. The machine handles the unpromising and ponderous material in a remarkable manner. On a core of sheet iron gauge rings are arranged at suitable distances and steel rods or wires of small section are passed through holes in these gauge rings and are arranged to pass longitudinally along the core. The rods or wires are portions of the reinforcement, but are not stretched, as the operation of applying the concrete draws them taut. The core is mounted on trestles, which are drawn gradually along as the concrete is applied. The concrete falls on a conveyor band of strong steel wire tightly plaited, that takes one wrap round the core. By means of two heavily weighted levers a sliding carriage applies a pressure of about 5,000 pounds to the conveyor belt, so that the concrete is wrapped on the core under that pressure. On the conveyor is a grip for a band of strong cloth webbing. The concrete falls on this webbing and the webbing and the concrete are wrapped round the core in a continuous spiral. Before that is accomplished, however, and immediately the webbing and concrete issue beyond the conveyor belt, wire or wires, as close as may be desired, are fed into the concrete and are wound round the core and drawn into the concrete by the rotation of the core. A finish is given to the webbing by a pressure roller. The thickness of the layer of concrete is reduced by the great pressure, and, of course, the quantity of webbing originally fed into the machine is too long, but the slack is ingeniously taken up by an elevator attachment.

The pipe or pole comes out of the machine wrapped up in a bandage of webbing and with a core inside; the latter may be removed in 12 hours, and the former after about 6 days' hardening. The pipes may be finished inside with a cement grout wash, and may receive a coat of Dr. Angus Smith's solution or a special cement glaze. The concrete may be made impermeable, too, by the addition of a special waterproofing; Messrs. Siegwart, Limited, recommend "Medusa" waterproofing material. If need be, a taper can be given to a pole. Poles are made up to 39 feet long, and pipes up to 20 feet long, but there is really no limit in the matter of dimension. Obviously the cost is small as compared with pipes, etc., made of iron. The thickness of the concrete varies from 1 to 2 inches in the poles, and from ¾ to 2 inches in the pipes. A Siegwart pipe, that has been tested, successfully resisted an internal hydraulic pressure of 285 pounds per square inch. The pipes have a special shaped joint for resisting pressure. Bitumen is filled into the hollow spaces of the joint, and a short piece of pipe is passed over the joint and connected to the pipe with bitumen. For ordinary pipes not called upon to sustain pressure, the jointing is by means of collars of reinforced concrete or sockets on the pipes. The principal purposes to which the invention can be applied are enumerated as follows by those concerned in its exploitation:

(1) Poles of all sizes and descriptions for telegraph, telephones and tramways, power transmission and electric lighting standards, lamp posts, railway signals, ventilating shafts and possibly ships' masts; (2) pipes of all descriptions for sewers, oil pipe lines, gas mains and water mains; (3) tubular members for constructional work, such as bridges, piers or columns for buildings; (4) piles, either tapering or cylindrical.

Items of Interest
FROM VARIOUS LOCALITIES.

Mr. Louis Lally, formerly on the staff of the Beloit (Wis.) Water, Gas and Electric Company, has joined the force of the Peoples Gas Light and Coke Company, of Chicago.

The entire possessions of the Federal Gas Company, of Texarkana, Tex., were sold at auction the 2d inst., the purchaser being Mr. William Steel, acting for the Dawes syndicate, of Chicago, which corporation owns the Texarkana Gas and Electric Company.

Mr. Thomas Randolph has been appointed Superintendent of the factories of the Welsbach Lamp Company in Columbus, O.

Mr. Joseph J. Dawes has been appointed power expert by the Rockford (Ills.) Electric Company. He had been in the employment of the Union Gas and Electric Company, of Cincinnati.

The following comes to us by way of Fort Wayne, Ind., under date of the 8th inst.: "According to public advertisement the name of the Company, which has succeeded to the properties of the Fort Wayne, Lafayette, Logansport and Wabash Valley, Indiana Natural and Illuminating Gas and the Ohio and Indiana Gas Companies, is that of the Indiana Consolidated Gas Company."

Mr. J. E. Sherman, President of the Marquette (Mich.) Light and Power Commission, it is said is "on the alert to discover a man who can give him a low cost of all the data necessary to enable the Commission to determine how much an expenditure would be required to construct a gas plant for operation on public account." Well, these men seem to be out of a job; at least they have not been heard from recently as "experts in gas matters: Prof. Bemis, Alton D. Adams and "Prof." Marks. They are all certainly cheap enough!

The Peoples Light Company, of Davenport, Ia., has put down a notable extension to its gas mains this summer.

It is possible that the idle gas plant at Little Falls, Minn., will be put in condition for a resumption of business.

The projectors of the Citizens Gas Company, of Indianapolis, Ind., have closed contracts for the major portion of the generating contracts, the successful bidder having been the United Coke and Gas Construction Company, of New York. Under the agreement that concern will construct 50 by-product ovens, complete.

The Borough Council, of Paulsboro, N. J., has ordered the contractor (Mr. F. D. Moses) to finish the plant, the validity of the bond issue having been satisfactorily determined. It is a municipal operation.

THE Springfield (Mass.) Gas Light Company lost one of its old-time gasholders during a severe electric storm the afternoon of the 5th inst. A bolt of lightning struck the center of the cupola (the holder was a covered one) first and then connected with the girders. The final result was an explosion which put the holder completely out of business. The damage otherwise was trifling, although two other holders were in close proximity. Our account of the matter puts the capacity of the vessel at 225,000 cubic feet.

ANOTHER explosion that resulted in considerable damage to the purifying plant of the Winona (Minn.) Company, was occasioned by the ignorance of a newly employed hand. A young chap named Anton Pillowski (one of the night shift), while going through the purifying plant thought he smelled gas. In trying to locate the escape he lighted a match, with the result, that an explosion instantly occurred, the force of which was sufficient to badly damage the boxes and the building. The worst thing about it was that two other men received painful injuries, while the chap who lighted the match got off with slight burns about the face and hands.

AT the annual meeting of the New Bedford (Mass.) Gas and Electric Light Company no change was made in the executive management.

MR. H. I. LEA, of Chicago, has purchased for personal account the properties of the Du Quoin (Ills.) Light, Heat and Power Company, and will operate the same. Mr. Lea has planned several changes in the method of conducting the business, especially as to the office management, which hitherto has not been altogether of the sort that breeds contentment. We are pleased to say that Mr. H. H. Thwing is to remain as Superintendent. Success to Mr. Lea in full measure over his venture, for it is certain that if sensible, sustained work is to be rewarded reward will certainly be his portion.

A SPECIAL meeting of the shareholders of the Bay State Gas Company is called for 11 A.M., of to-day, in the Ford Building, Wilmington, Del.

THE electrical division of the properties of the Rochester (N. Y.) Railway and Light Company has determined upon using oil for fuel in the power division. Oil tank builders might find it useful to have a try at figuring on the storage tanks that will be needed.

ACCORDING to the returns for the month of July made by Manager Snow, to the municipal authorities of Holyoke, Mass., respecting the gas and electric sendout for that city during the month of July, it appears that the percentage gain in the former, over the prior month of June, was 12.01; the electric gain was 5.01. The gas output for July was 13,986,885 cubic feet; the electric output for the same month was 360,880 kilowatts.

THERE has been so much said about the explosion or bursting of a flywheel of an engine in the power room of the North Adams (Mass.) Gas Light Company that we reprint the following authentic account of the happening, that appeared in the North Adams evening *Transcript*, of the 1st inst., which account was forwarded by a correspondent, under date of the 9th inst.: "A 12-ton flywheel burst at the works of the North Adams Gas Light Company at about 9:30 this morning, during considerable damage. Pieces of the wheel crashed through the walls and roof and flew with terrific force north of the building. One piece of the wheel was hurled through the air 500 feet and struck against the walls of the Arnold Print Works across the river, knocking a hole about 2 feet in diameter through the brick wall just below the top story. Another piece fell on the railroad track and buried itself in the dirt. Still another piece about 4 feet long dropped in the roadway, on the side of the river near the works, about 200 feet from the building. Several other pieces of the wheel lay strewn along the line in which the wheel expended its enormous energy. The shafting of the wheel, which weighs several tons, was found completely reversed after the bursting of the wheel, showing that it had been thrown into the air by the force of the wheel and twisted through a half revolution. Fortunately no one was killed or injured, though there was considerable danger inside the building, and also outside on the grounds where the big pieces of iron fell. The exact cause of the accident is not known. From some cause the engine, a 500-horse power cross compound condensing engine, began to race. Perhaps some bolt gave way, or some connection loosened. Something outside the responsibility of the engineer started the racing, and the low pressure side seemed to run away with the high pressure side. Chief Engineer F. B. Briggs and two other engineers were in the building at the time, and Engineer Briggs saw that something was the matter with the engine, and started to shut it down. He had reached the emergency shut off and operated the automatic push button which closed the throttle when the wheel burst. The wheel was 15 feet in diameter, and the pit in which it hung is now a mass of rubbish and splintered wood. The engine demolished is one of those which furnish the power for the high tension lines for Williamstown and Adams, and also for the ventilating fan in the central shaft of the Hoosac tunnel. This is the first accident which has occurred at the works of the North Adams Gas Light Company for 18 years, and the loss, about $10,000, is fully covered by insurance. The plant is not expected to be crippled, and all sections will be supplied with light as usual to-night. Further investigation will be made in an effort to discover more exactly the cause of the trouble."

MR. D. A. BARNES, who last June resigned from the staff of the Grand Rapids (Mich.) Gas Company to take a more important position with the Columbus (Ind.) Gas Company, and then was stricken down with typhoid fever, has recovered. He took charge at Columbus last week.

THE Equitable Guarantee and Trust Company, of Wilmington, Del., as Trustee of the first mortgage issue of 6's, made by the Sunbury (Pa.) Gas Light Company, and maturing March 1, 1916, has notified the holders thereof that all the bonds have been called for redemption. Those offered will be taken up with principal and interest to date of the first prox., on which date interest is to cease.

"V. J. M.," writing from Plainfield, N. J., under date of the 7th inst., incloses the following: "The spineless collection that articulates here under the guise of a Common Council early this week referred back to the Building Inspector, Mr. T. O. Doane, the petition of the Public Service Commission for permission to erect a gasholder on its property close to the business center of the city. The Councilmen appealed to Acting Corporation Counsel Runyon for an opinion as to who had jurisdiction in the premises, and he kindly advised that jurisdiction was and is confined to the Building Inspector—heretofore one could not construct a cesspool unless the Council had a voice regarding it. The comical part of the situation, however, is that the Runyon advice was given 2 months ago, and the Building Inspector wisely determined to keep quiet, and meanwhile the 'P. S. C.,' acting the part of believers that silence was nothing other than consent, quietly went on with the work. When it was well under way, however, one Charles H. Hand woke up with a start, entered a protest against the construction and declared that he will hold the Public Service Corporation liable for any damages. Wise man; Mr. Hand evidently is, for the Public Service Corporation is an eminently solvent body. Maturing thought, however, prompts the prediction that if Mr. Hand lives until he is paid damages over the moot point in question he will certainly come pretty near being the senior member of the 'Order of Oldest Inhabitants.'"

MR. F. C. WESSEL, formerly of Madison, Wis., has been appointed Manager of the gas division of the properties of the Cheyenne (Wyo.) Light, Fuel and Power Company.

THE Stacey Manufacturing Company has been awarded the contract for the construction of a 4-lift holder for the New Orleans Gas Light Company. It will rest in a steel tank and its rated capacity is 1,020,000 cubic feet.

MR. F. R. ELLENOR is said to be the main one interested in the proposition to construct a gas plant in Whalesville, Va.

THE North Shore Consolidated Gas Company has issued to the Central Trust Company, of Illinois, a trust deed of all its property to secure a bond issue of $3,000,000, to run for 30 years from August 1st, and to bear interest at 5 per cent. Of this issue $600,000 will be emitted forthwith, $700,000 are to be set aside for the redemption of a like sum of bonds of the North Shore Gas Company, and the balance will be issued as policy may require from time to time for acquiring, improving or bettering any or all of its properties. The bonds are subject to call for redemption prior to maturity on August 1, 1913, or any interest day thereafter, at 105 and interest. The Company operates plants in Waukegan, North Chicago, Lake Bluff, Lake Forest, Highland Park, Libertyville, Glencoe and Winnetka, Ills.

THE proprietors of the St. Clair County Gas and Electric Company have decided to hook up the plants at East St. Louis and Belleville, Ills., by means of a 6-inch line. When completed, the Belleville plant will be shut down.

THE AMERICAN GAS LIGHT JOURNAL

MONDAY, AUGUST 17, 1908.

The Market for Gas Securities.

The rise in Consolidated was sufficiently h'gh and rapid to cause the offering of quite a bit of long stock. The result was a recession in price, although the moment the market was bare of selling orders quotations would mount ¼ point at a time. We repeat our advice that this stock is still a purchase. The noon rate to-day (Friday) was 137½ to 138.

Brooklyn Union well maintains its recent advance Bay State sold up to 3¼ and then sagged off to 2¼. It is quoted to-day at 2⅝ to 2¾. About this stuff we cannot advise anything, as our relations with the people now in control of it are completely inharmonious. The general gas list is strong, especially in the instance of bonded issues.

Gas Stocks.

Quotations by George W. Close, Broker and Dealer in Gas Stocks.

16 WALL STREET, NEW YORK CITY.

AUGUST 17.

☞ All communications will receive particular attention.

☞ The following quotations are based on the par value of $100 per share:

N. Y. City Companies.	*Capital.*	*Par.*	*Bid.*	*Asked.*
Consolidated Gas Co.	$73,177,000	100	137½	138
Central Union Gas Co.—				
1st 5's, due 1927, J. & J.	3,000,000	1,000	93	98¼
Equitable Gas Light Co.—				
Con. 5's, due 1932, M. & S.	1,000,000	1,000	—	105
Mutual Gas Co.	3,500,000	100	180	190
New Amsterdam Gas Co.—				
1st Con. 5's, due 1948, J. & J.	11,000,000	1,000	92	96
New York & Richmond Gas Co. (Staten Island)	1,500,000	100	37	43
1st Mtg. Gold Bds. 5 p. ct.	1,000,000	—	98	104
New York and East River—				
1st 5's, due 1944, J. & J.	3,500,000	1,000	100	105
Con. 5's, due 1945, J. & J.	1,500,000	—	97	101
Northern Union—				
1st 5's, due 1927, J. & J.	1,250,000	1,000	90	98
Standard	5,000,000	100	70	100
Preferred	5,000,000	100	100	125
1st Mtg. 5's, due 1930, M. & N.	1,500,000	1,000	100	105
The Brooklyn Union	15,000,000	1,000	127	130
1st Con. 5's, due 1948, M. & N.	15,000,000	—	91½	92
Yonkers	999,6 0	500	130	—
Out-of-Town Companies.				
Bay State	50,000,000	50	2⅝	2¾
" Income Bonds	2,000,000	1,000	—	75
Binghampton Gas Works	450,000	100	—	65
" 1st Mtg. 5's	500,000	1,000	95	100
Boston United Gas Co.—				
1st Series S. F. Trust	7,000,000	1,000	82	85
2d " " "	3,000,000	1,000	47½	50
Buffalo City Gas Co.	5,500,000	100	5	8
" " Bonds, 5's	5,250,000	1,000	63	66
Capital, Sacramento	500,000	50	—	35
Bonds (6's)	150,000	1,000	—	—
Chicago Gas Co. Guaranteed Gold Bonds	7,660,000	1,000	104	106¼
Cincinnati Gas and Electric Co.	29,500,000	100	91½	92
Columbus (O.) Gas Co., 1st Mortgage Bonds	1,500,000	1,000	92	98
Columbus (O.) Gas Lt. & Heating Co.	1,682,750	100	87	88
Preferred	3,026,500	100	71	80
Consumers, Toronto	2,000,000	50	200	204
Consolidated, Baltimore	11,000,000	100	—	105
Mortgages, 6's	3,600,000	—	—	118
Chesapeake, 1st 6's	1,000,000	—	—	—
Equitable, 1st 6's	910,000	—	—	—
Consolidated, 1st 5's	1,490,000	—	—	112
Consolidated Gas Co. of N. J.	1,000,000	100	15	17
Con. Mtg. 5's	880,000	1,000	92	95
Bonds	75,000	—	—	100
Denver Gas and Electric	—	—	74½	75
Detroit City Gas Co	6,000,000	50	—	50
Prior Lien 5's	4,618,000	1,000	—	98
Detroit Gas Co., 5's	381,000	1,000	75	80
" nc. 5's	16,000	100	98½	100
Equitable Gas & Fuel Co., Chicago, Bonds	2,000,000	1,000	—	101
Essex and Hudson Gas Co.	6,500,000	—	39	40
Fort Wayne	2,000,000	—	—	—
" Bonds	2,000,000	—	55	—
Grand Rapids Gas Light Co., 1st Mtg. 5's	1,225,000	1,000	104½	105
Hartford	750,000	25	190	200
Hudson County Gas Co., of New Jersey	10,500,000	—	100	105
" Bonds, 5's	10,500,000	—	101	102½
Indianapolis	2,000,000	—	60	70
" Bonds, 5's	2,650,000	—	104½	105
Jackson Gas Co.	250,000	50	82	—
" 1st Mtg. 5's	290,000	1,000	97	100
Kansas City Gas Light Co., of Missouri	5,000,000	100	—	36
Bonds, 1st 5's	3,822,000	1,000	102	104
Laclede Gas Co., St. Louis.	10,000,000	100	—	100
Preferred	2,500,000	100	60	90
Bonds	10,000,000	1,000	104	104¼
Lafayette Gas Co., Ind.	1,000,000	100	—	60
Bonds	1,000,000	1,000	60	65
Louisville	2,570,000	50	143	145
Madison Gas and Electric Co.				
" 1st Mtg. 6's	350,000	1,000	106	108¾
" 6 per cent. scrip, due 1910	100,000	25	60	60½
Massachusetts Gas Companies, of Boston	25,000,000	100	54	54¼
Preferred	25,000,000	100	84½	85
Montreal Gas Co., Canada	2,000,000	100	218	218¾
Nashville Gas Light Co.	1,000,000	100	110	—
Newark, N. J., Con. Gas Co.	6,000,000	—	56	58
Bonds, 6's	6,000,000	—	137	138
New Haven Gas Co.	2,000,000	25	200	—
Peoples Gas Lt. & Coke Co., Chicago	25,000,000	100	96	96½
1st Mortgage	20,100,000	1,000	—	—
2d "	2,500,000	1,000	104	—
Rochester Gas & Electric Co.	2,1 0,000	50	88	—
Preferred	2,150,000	50	118	—
Consolidated 5's	2,000,000	—	104½	105½
San Francisco Gas Co., Cal.	15,500,000	—	—	—
St. Joseph Gas Co.—				
1st Mtg. 5's	751,000	1,000	92	—
St. Paul Gas Light Co.	1,500,000	100	45	47
1st Mortgages, 6's	620,000	1,000	113	116
Extension, 6's	600,000	1,000	112½	115
General Mortgage, 5's	2,445,000	1,000	96¾	—
Syracuse Gas Co., N. Y	1,975,000	100	50	55
Bonds	2,047,000	1,000	102	—
Washington (D. C.) Gas Co.	2,600,000	20	322½	328
1st Mortgage, 6's	600,000	—	—	—
Western Gas Co., Milwaukee	4,000,000	—	—	—
Wilmington (Del.) Gas Co.	600,000	70	230	—

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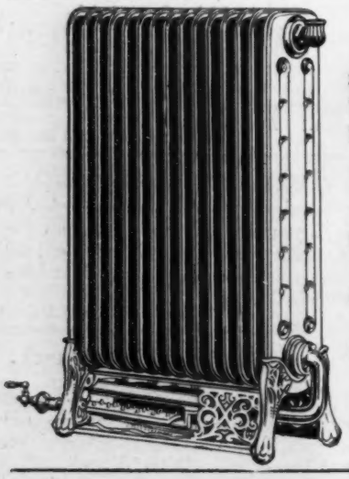

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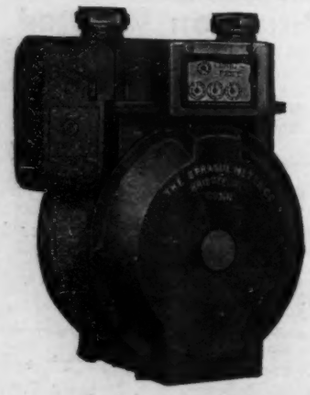

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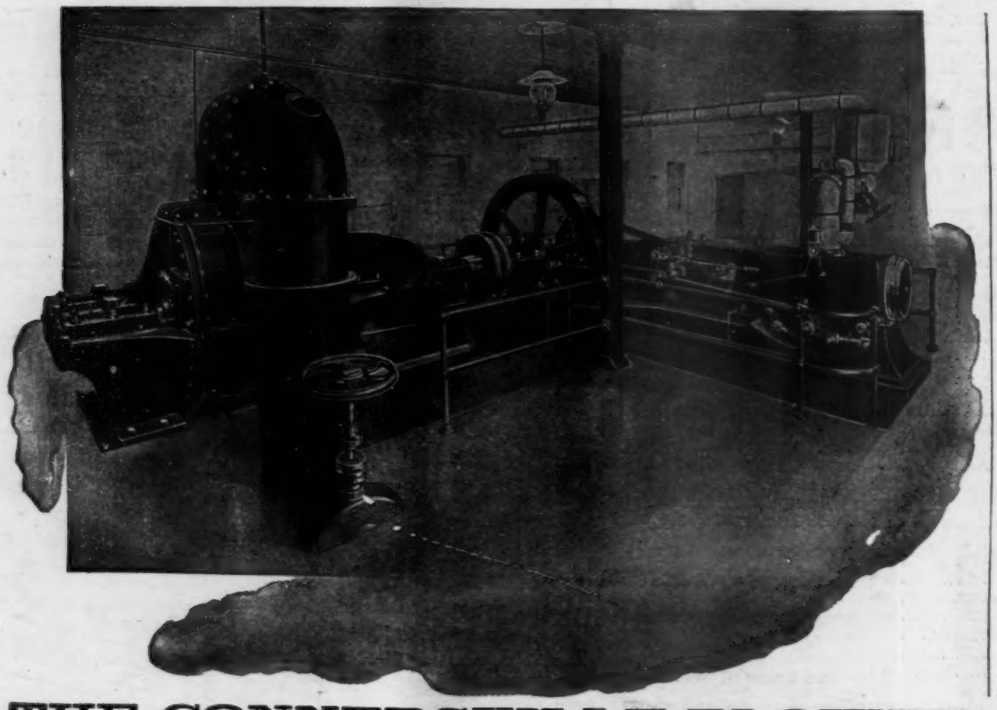

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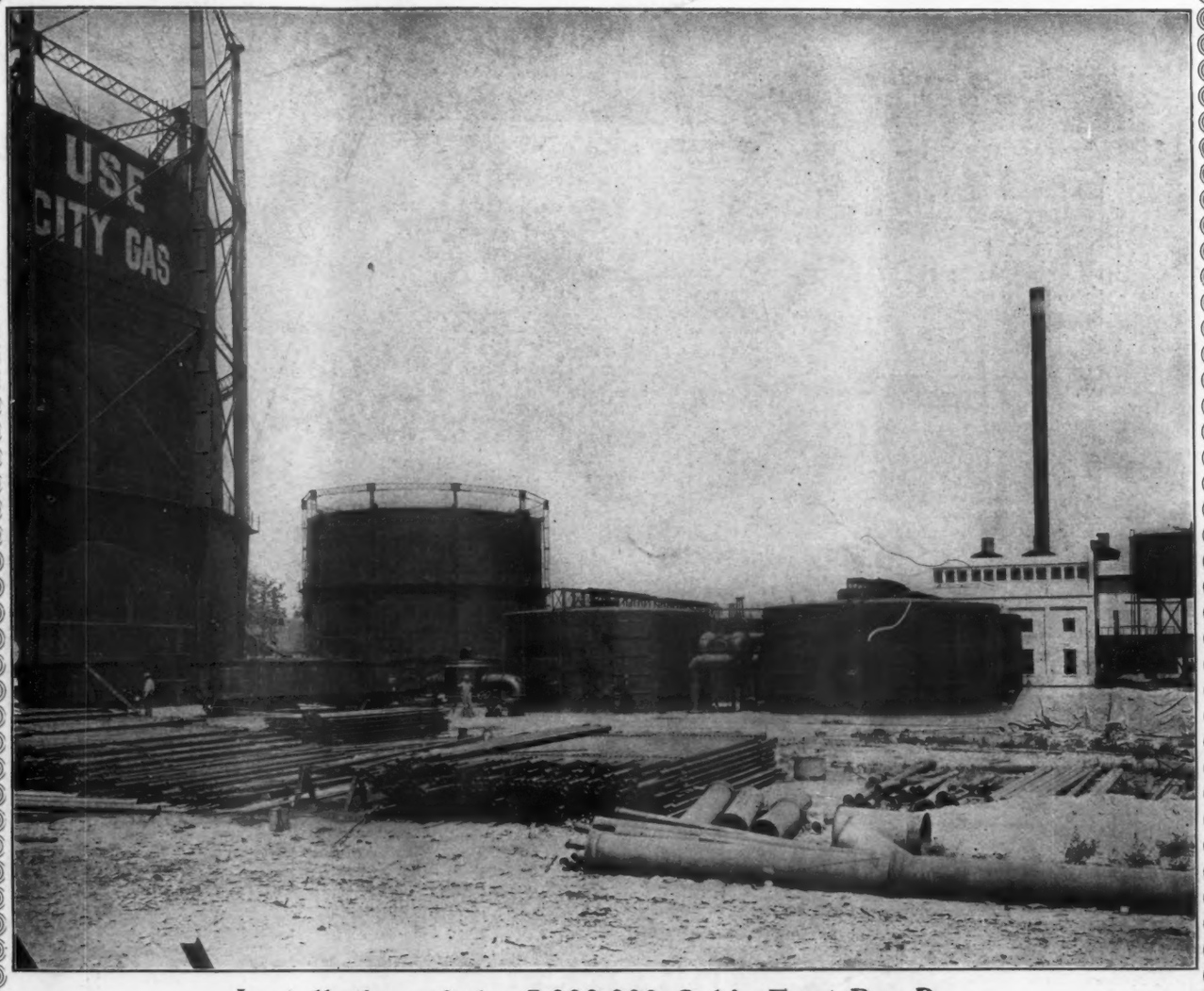

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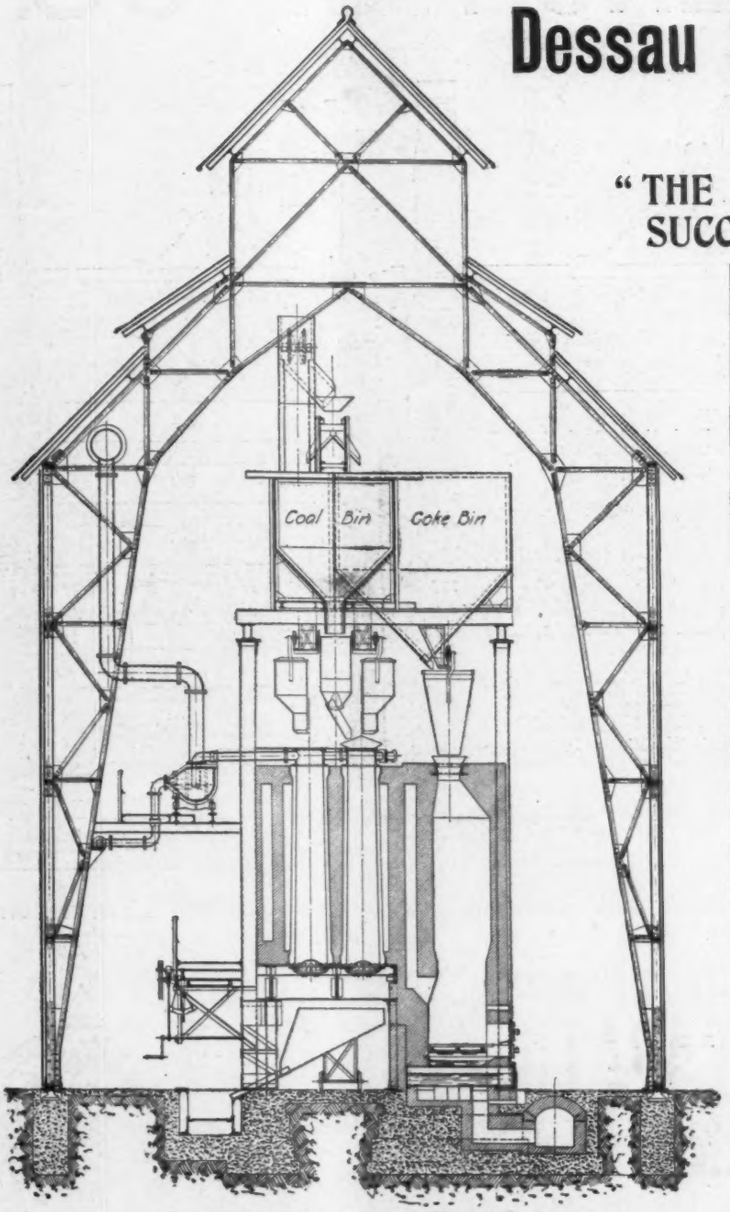

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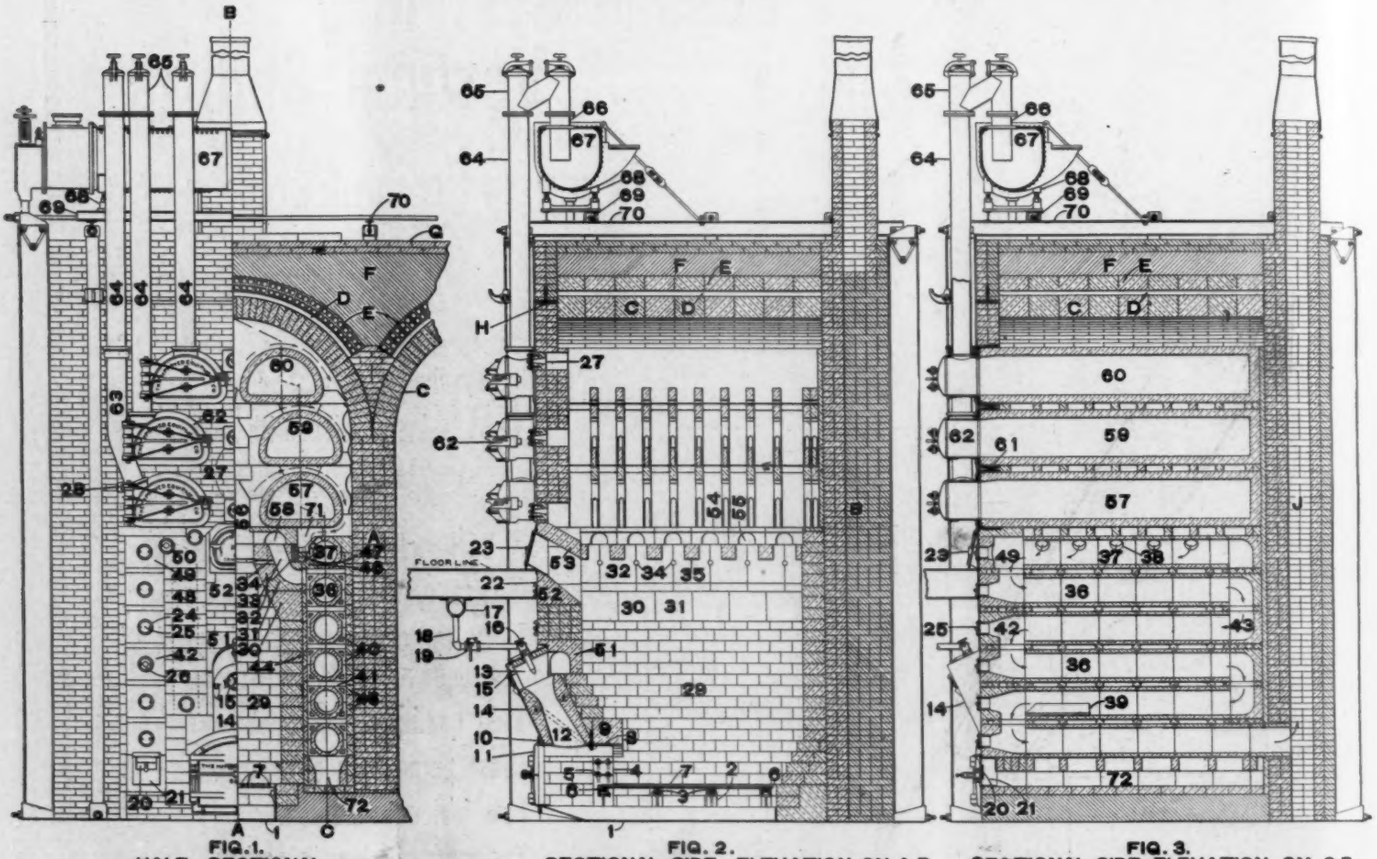

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FIG. 2. SECTIONAL SIDE ELEVATION ON A-B

FIG. 3. SECTIONAL SIDE ELEVATION ON C-B

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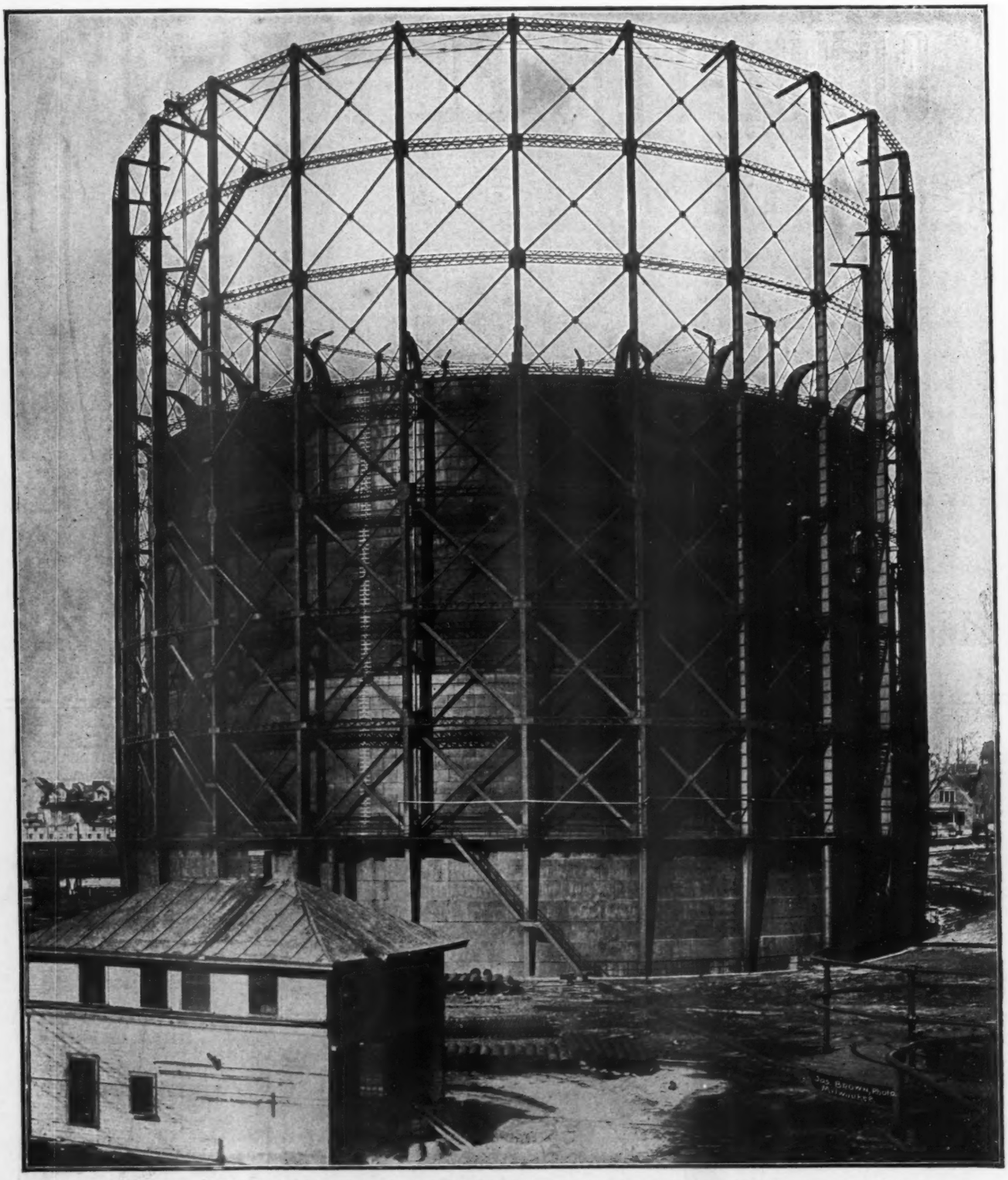

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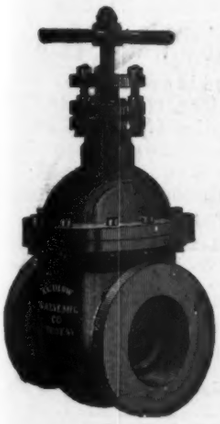

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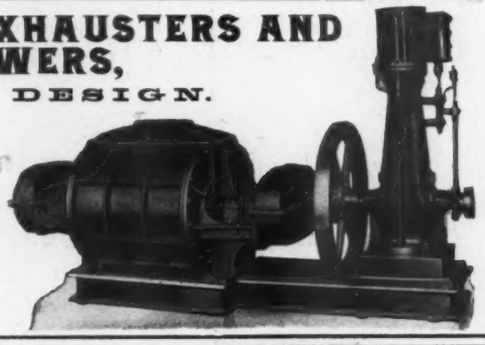

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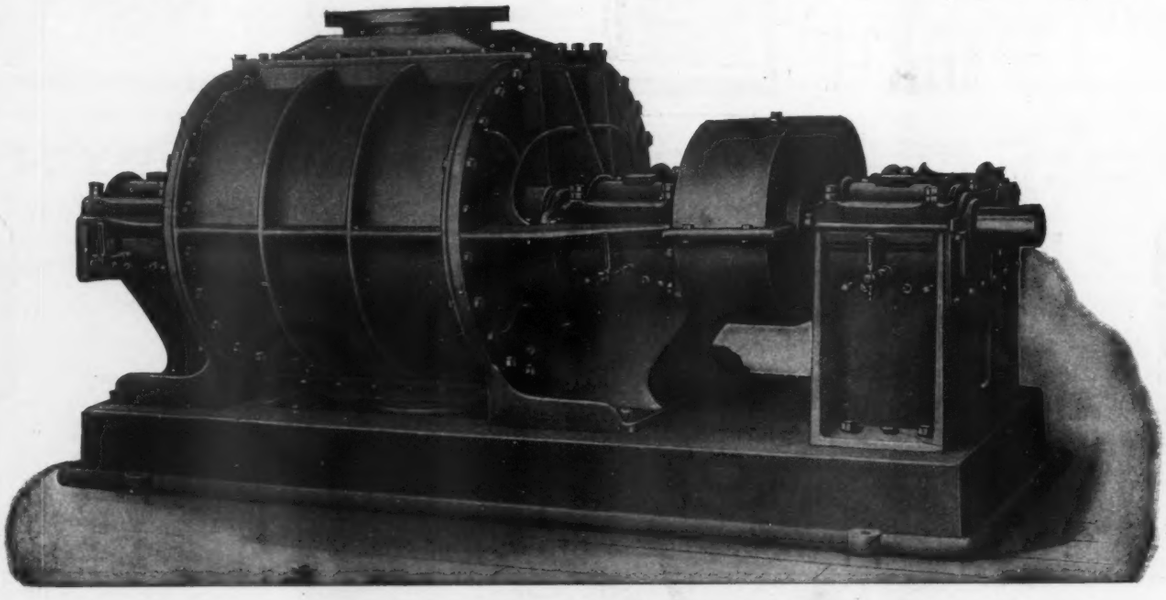
The highest efficiencies obtained. Most perfect devices for adjustment and maintenance of proper alignment. Use our flexible coupling to correct troubles caused by misalignment and engine shaft thrust. Our gas governor is the best. By-pass, gas valves and fittings.



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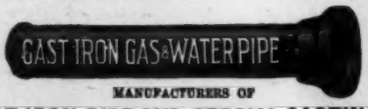

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Manufacturers of BRISTOL'S

Recording Pressure Gauges, Recording Vacuum Gauges,
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THE WM. H. BRISTOL ELECTRIC PYROMETERS
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PATENT SMOKED CHART RECORDERS.

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Bray's Special Burner.

BRAY'S MARKET OR STANDARD BURNERS.

For Markets, Meat Shops, Fruit Stands, Show Windows, Street Lamps, and all places where high candle power is required.

These Burners Give a Large, Well-Shaped Flame.

They are Very Durable and Can be Depended Upon to Give Satisfactory Service for Years.

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For 1906-1907,

Showing at a glance the Accounts of 113 Coal and Water Gas Companies, Itemized under

Coal Carbonized, Gas Made and Sold, Yield of Residuals, Public Lamps, Mileage of Mains, Consumers, Price of Gas, Illuminating Power, Financial Results, Revenue.

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AMERICAN METER CO.,

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Photometrical and Experimental Apparatus.

PUBLIC LIGHTING TABLE.

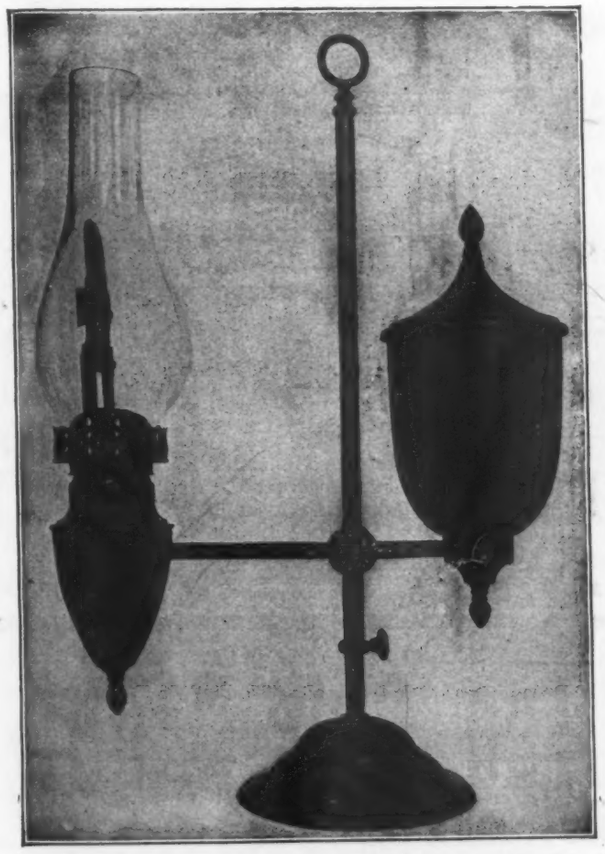
SEPTEMBER, 1908.

Day of Week.	Date.	Table No. 1. Following the Moon. Light.	Extinguish.
Tue.	1	8.30 PM	4.30 AM
Wed.	2	9.10	4.30
Thu.	3	9.50 FQ	4.30
Fri.	4	10.30	4.30
Sat.	5	11.30	4.30
Sun.	6	12.40 AM	4.30
Mon.	7	1.50	4.30
Tue.	8	3.10	4.30
Wed.	9	No L.	No L.
Thu.	10	No L FM	No L.
Fri.	11	No L.	No L.
Sat.	12	6.50 PM	8.50 PM
Sun.	13	6.40	9.30
Mon.	14	6.40	10.00
Tue.	15	6.40	10.30
Wed.	16	6.40 LQ	11.10
Thu.	17	6.40	12.00
Fri.	18	6.40	12.50 AM
Sat.	19	6.40	1.40
Sun.	20	6.30	2.40
Mon.	21	6.30	3.40
Tue.	22	6 30	4.50
Wed.	23	6.30	4.50
Thu.	24	6.30	4.50
Fri.	25	6.30 NM	4.50
Sat.	26	6.30	4.50
Sun.	27	6.20	4.50
Mon.	28	6.20	4.50
Tue.	29	6 20	4.50
Wed.	30	7.50	4.50

TOTAL HOURS DURING 1908.

By Table No. 1.

	Hrs.Min.
January	228.30
February	187.30
March	192.00
April	160.10
May	155.10
June	138.00
July	155.50
August	173.40
September	185.20
October	214.00
November	218.10
December	226.40
Total, yr.	2235.00



THE ELLIOTT KEROSENE STANDARD PHOTOMETER LAMP.

10-Candle Power.

This lamp is a perfect substitute for the 10-candle Pentane Lamp hitherto used, and has the following advantages:

1st. It uses Standard Kerosene Oil (Pratt's Astral Oil or equivalent).

2d. It is remarkably steady. Will burn 24 hours continuously with less than 2 per cent. variation.

3d. It is much less dangerous than Pentane, which is a kind of gasolene.

4th. It is not easily affected by air currents in the photometer room.

5th. Since the lamp may burn continuously, the candle power of gas may be taken at any moment, if necessary. This insures steady illuminating power without waste of carburetting material.

6th. The first cost of the lamp brings it within the reach of even small gas works.

7th. Costs much less to maintain than a Pentane lamp or sperm candles doing the same service.

8th. Is not affected by the weather.

PUBLIC LIGHTING TABLE.

SEPTEMBER, 1908.

Day of Week.	Date.	Table No. 2. New York City. All Night Lighting. Complete Lighting in One Hour From Time Given P. M.	Complete Extinguishing in 50 Minutes From Time Given A.M.
Tue.	1	6.27	3.57
Wed.	2	6.27	3.57
Thu.	3	6.17	4.07
Fri.	4	6.17	4.07
Sat.	5	6.17	4.07
Sun.	6	6.17	4.07
Mon.	7	6.12	4.07
Tue.	8	6.12	4.07
Wed.	9	6.12	4.07
Thu.	10	6.02	4.17
Fri.	11	6.02	4.17
Sat.	12	6.02	4.17
Sun.	13	6.02	4.17
Mon.	14	6.02	4.17
Tue.	15	6.02	4.17
Wed.	16	6.02	4.17
Thu.	17	5.52	4.27
Fri.	18	5.52	4.27
Sat.	19	5 52	4.27
Sun.	20	5.52	4.27
Mon.	21	5.47	4.27
Tue.	22	5.47	4.27
Wed.	23	5.47	4.27
Thu.	24	5.37	4.37
Fri.	25	5.37	4.37
Sat.	26	5.37	4.37
Sun.	27	5.37	4 37
Mon.	28	5.32	4.37
Tue.	29	5.32	4.37
Wed.	30	5.32	4.37

TOTAL HOURS DURING 1908.

	Hrs.Min.
January	481.50
February	329.15
March	351.50
April	341.50
May	233.05
June	218.10
July	282.55
August	254.55
September	292.25
October	420.45
November	374.30
December	411.05
	3992.35
Deduct on account of 50 min. extinguishing time	30.30
Total, yr.	3962.05

NEW YORK, 318 West 42d Street.
BOSTON, 820 Beacon Building.
PHILADELPHIA, Broad and Arch Streets.
ST. LOUIS, 712 Roe Building.
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....OF AMERICA....

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Controls and Operates the **Welsbach System of Street Lighting,**

Which includes its specially DESIGNED and PATENTED BURNER for PARK LIGHTING exclusively.

Uniformly SUCCESSFUL in 150 Cities and Towns.

By means of the Welsbach System of street lighting the superiority of GAS over electricity for street lighting has been fully demonstrated.

POINTS OF MERIT:

It is { Economical, Attractive, Successful, Up-to-date.

IT LIGHTS THE STREET.

Where there are no gas mains we can furnish an equally good light by our SELF-GENERATING NAPHTHA WELSBACH BURNER, and thereby supply a uniform light in all localities.

Correspondence Solicited from Gas Companies and Others interested in Municipal and Outside Lighting.

No. 38.

The Chic Light.

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For decorative appearance and large volume of light at a popular price to the consumer,

THE CHIC LIGHT

is practically alone in the field. Complete satisfaction to the user is its strong point.

THE CHIC LIGHT—Design No. 71310.

PRICES:

Boxed complete, with No. 71 Welsbach burner, No 310 F. Q. M. cylinder, No. 196 Junior J Brand Welsbach mantle, including the No. 316 opal shade, which will be packed separately.

Price, complete, clear cylinder, each, dozen lots, ... $1.35
Price, complete, clear cylinder, 100 lots, each, ... 1.25

When supplied with **No. 310 F. Q. M. Opal Cylinder** add 10 cents to above list.

Price of Shade No. 316.
Package Contains 16 Dozen.

Price, per dozen, ... $4.40
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Salesrooms in all Leading Cities of the United States.

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Everett, Mass.
Jenkintown, Pa. (2d contract).
Coney Island, N. Y.
Mexico, Mo.
Jacksonville, Fla.
Syracuse, N. Y. (2d contract).
Atlanta, Ga. (2d contract).
Holyoke, Mass.
Peoria, Ills.
Schenectady, N. Y. (2d contract).
Danbury, Conn.
Galveston, Tex. (2d contract).
Quebec, Canada.
Indianapolis, Ind. (2d contract).
Bessemer, Ala.
Waterbury, Conn. (5th contract).
Sioux Falls, S. D. (3d contract).
Philadelphia, Pa.
New Hartford, Conn.
Poughkeepsie, N.Y. (2d contract).
Nashville, Tenn.
Salisbury, Md.
Norfolk, Va. (4th contract).
Wallingford, Conn.
Richmond, Va. (2d contract).
Oak Bluffs, Mass.
Arlington, Mass.

TOTAL SETS INSTALLED DURING YEAR, ... 43
TOTAL SETS INSTALLED TO DECEMBER 31, 1907, ... 677
TOTAL DAILY CAPACITY, TO DECEMBER 31, 1907, ... 545,865,000 cu. ft.

Tar Extractors for Carburetted Water Gas.
Photometrical Apparatus.
Gas Analysis Apparatus.
Recording Gauges.
Straight Standpipe System for Coal Gas Retorts.
Straight Standpipe Cleaners.
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Ground Fire Clay, Fire Sand and Ground Fire Brick in Barrels and Bulk.

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HALF AND FULL DEPTH AND FREE FIRING BENCHES,

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We will guarantee "Better Benches," to be easier to control, make more gas per retort, and operate with less fuel than any bench on the market.

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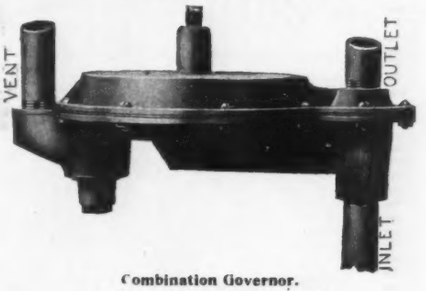

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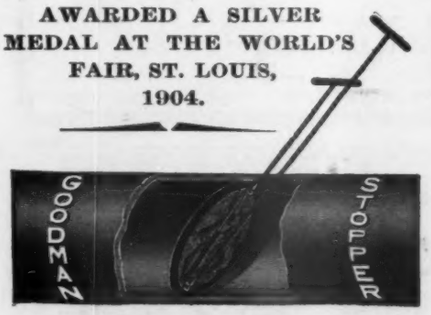

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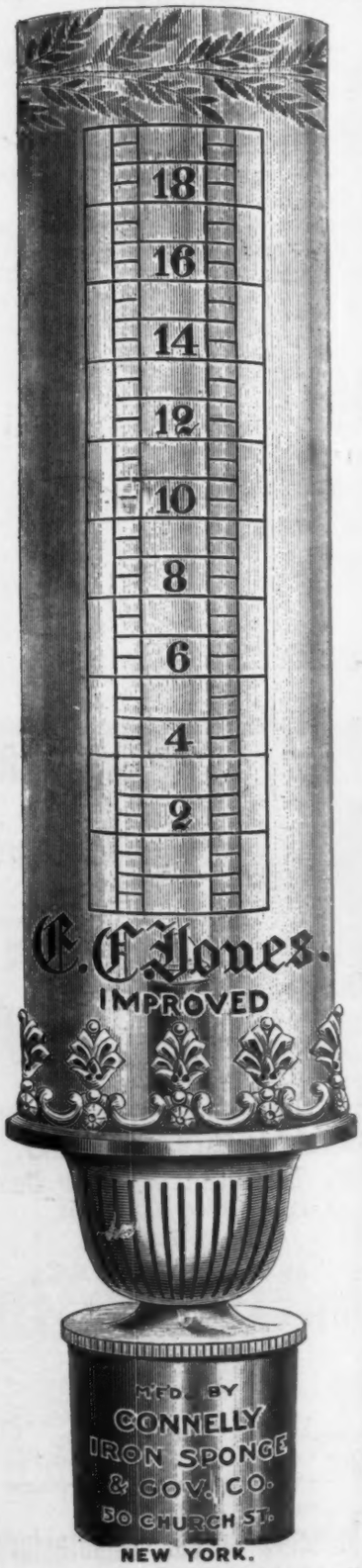

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Strong, Simple, Durable. Will Crush any Size Desired.

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WITHOUT ANY ESCAPE OF GAS.

They are Strong and Compact.

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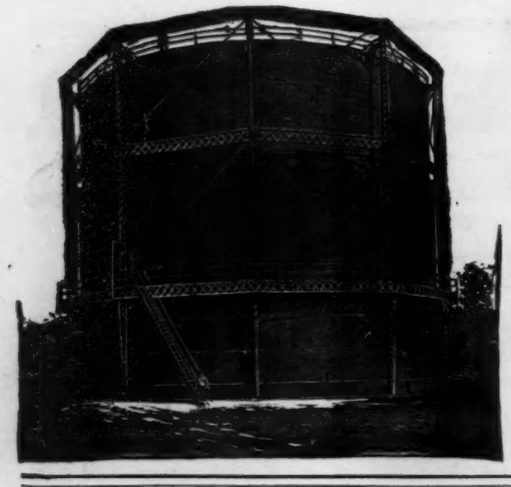

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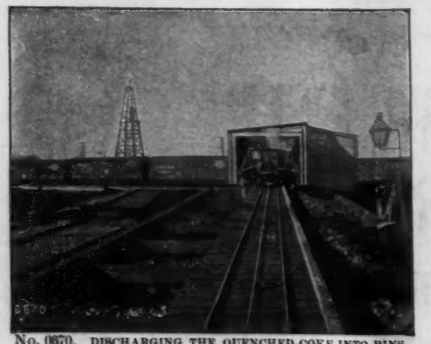

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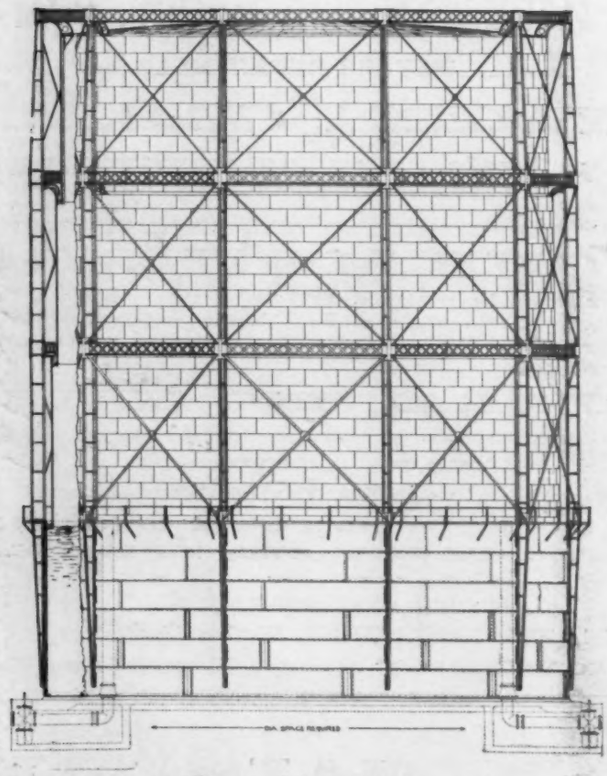

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